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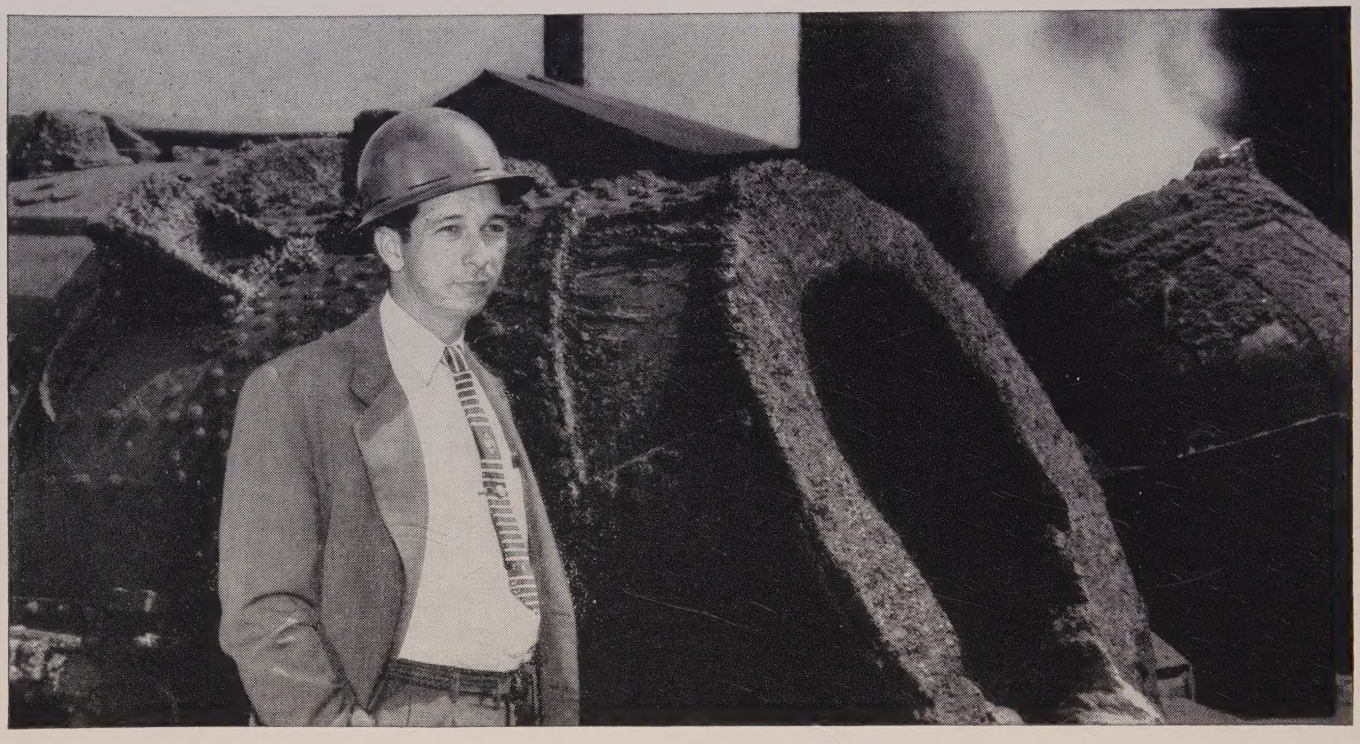
ILLINOIS TECHNOGRAPH

NOVEMBER, 1956 .25

Leroy J. Sauter, class of '49,
speaks from experience when he says:

"The variety of jobs open to engineers with United States Steel offers satisfaction and a great future."



In 1949, Leroy J. Sauter was graduated from the University of Pittsburgh with a B.S. in Metallurgical Engineering. Today, Mr. Sauter holds the important post of Superintendent, Open Hearth and Bessemer Department at National Works of United States Steel's National Tube Division.

Before his college days, and as far back as October, 1939, Mr. Sauter was employed as a chipper, a molding helper, and helper on an electric furnace at the United States Steel's Johnstown Works. Then, from 1943 until 1945, he served in the U. S. Navy. He entered the University of Pittsburgh in 1946, graduating within three years.

In February of 1949, Mr. Sauter was employed by United States Steel as a student engineer. In October, 1950, he became a process engineer in the Open Hearth and Bessemer Department. In April, 1952, he was advanced to practice engineer in the same department, and three months later, July, 1952, Mr. Sauter was appointed Assistant Superintendent of the Open Hearth and Bessemer Department. His elevation to his present position of Superintendent of this department occurred in December, 1955.

Today, Mr. Sauter supervises 316 men, being responsible for and assuring the productivity, quality of product, and general morale of this group. His responsibility further extends to the complete operation of his department, operating costs, meeting ingot requirements and complete scheduling of equipment.

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So ends the ad. Mr. Harris says these are needed, for our "founding fathers were for the most part, highly educated men, proud of their broad grasp of affairs and the greatness they conceived will not in the long run rest on our industrial power or our scientific ingenuity, but only upon the quality of our social, our moral, and our psychological thinking."

While we agree substantially with him, we believe he makes too little of scientific knowledge. Unfortunately the world makes too much of it at the expense of the other and we fear the ad Mr. Harris envisions will not appear until the time when we can take stock and reevaluate our needs, goals and aims.

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THE ILLINOIS TECHNOGRAPH

Volume 72 **Number 2**

Contents:

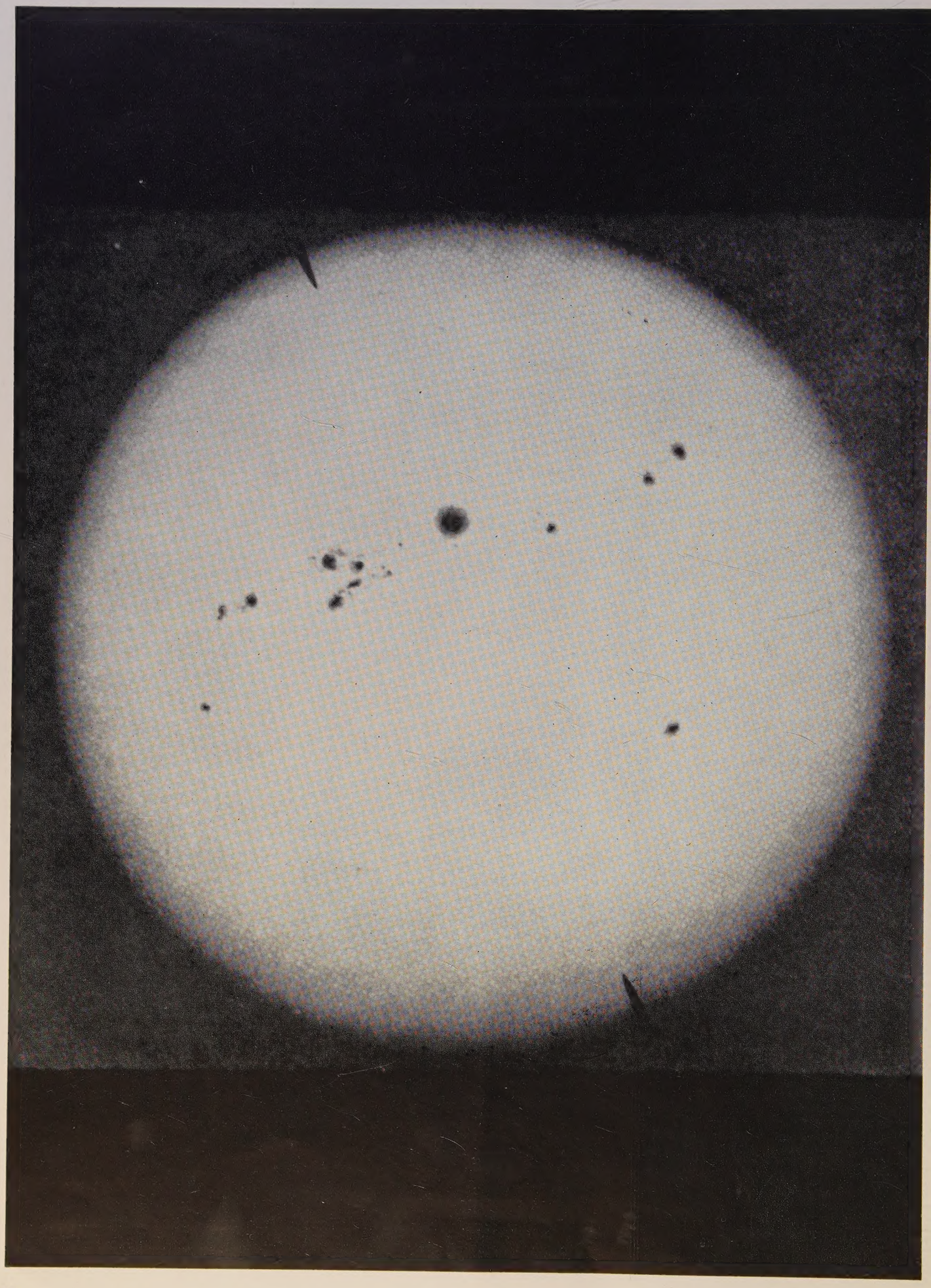
Editorial ---------- 5
Sunspots ---------- 11
Color TV ---------- 19
Nikola Tesla ---------- 28
Inspection Trip ---------- 34
Trip Schedules ---------- 46
Society Column ---------- 49
Skimming ---------- 59
Book Review ---------- 68
Technical Writing ---------- 73
Technocracks ---------- 80

Our Cover

In yesterday's cornfield a giant new electric power plant takes form. Thus does Stanley Meltzoff tell the story of never-ending expansion and development on the part of American's responsible utilities in the interest of adequate electric power for homes and industry. (Reproduced through the courtesy of United Engineers & Constructors, Inc., of Philadelphia, Chicago and New York)

Our Frontispiece

Our frontispiece—The surface of the sun dotted with solar storms or sunspots. (All photos are courtesy of E. Van Nostrand and Co.)



Solar Disturbances . . .

SUN SPOTS

by Donald Georgi, E. E. '59

I. Historical Significance

Through the complete history of man's existence, the sun of this solar system has daily provided energy to all life here on earth. Man, in all this time, has recognized, studied, and even worshipped the sun, as is proven by the remains of Egyptian temples dedicated solely to the sun god, Ra. The photosphere, or visible face of the sun, has many variable actions which affect the electromagnetic radiation emitted by the sun. The most obvious of these variable features is the phenomenon of sunspots, which are considered to be a type of solar storm. Chinese records dating back to 28 B.C., tell of "flying birds" which were observed on the sun. Astronomers today interpret those observations as being such large sunspots that they were visible to the naked eye.

Conclusive proof of sunspots' existence, however did not come until 1610, when Galileo observed and began a study of the solar storms. Since that time scientific interest in the sun has grown, until the present time when we make daily permanent records and observations of the sun's activity with the aid of photography. Two basic types of photographs are taken of the sun. The normal method of photographing all frequencies of light shows granules, spots, and faculae of the sun. The other method, using spectro-heliographs, which are sensitive to only one frequency of light, shows solar occuli, flares, and prominences. From all these observations of sunspots astronomers have drawn many conclusions as to the characteristics and existence of sunspots. The significant reasons for studying sunspots are few, but important. It is known that radio transmission is disturbed through the effects of the sunspots on the ionosphere of our atmosphere. The only other truly important effect of sunspots concerns polar aurorae on the earth. It is known that these aurorae are definitely a result of terrestrial magnetism, which is due greatly to the magnetism of the sunspots.

II. Appearance

Sunspots appear to be small, black areas, the largest of which cover no more than one per cent of the total area of the photosphere. The central portion of a sunspot, called the umbra, is very dark compared to the area around it. The reason for the dark appearance of the sunspot is that the temperature of these solar storms is much lower than that of the surrounding surface. Estimates of the umbra temperature range from 4,300 K. to 4,800 K., whereas the temperature of the photosphere is around 6,000 K. Encircling this umbra is the penumbra, and although it is lighter than the umbra, it is only three-fourths as brilliant as the surrounding photosphere. It is often noticed that a complete group of small umbras will have a single penumbra. Observations of sunspots with a spectograph indicate that the gases of the sun's interior are moving toward the observer at the rate of one-half mile per second, while ionized calcium and neutral hydrogen on the surface have a motion inward. This noticed effect of solar gases coming out of the interior of the sun, observed with a spectograph, is called the Evershedd Effect. As these gases rush to the surface, they could be cooled when they expand, or the gases could acquire gravitational potential energy and cool the area of the spot as they rise. An interesting problem arises from this observed outflow of gases. It has been known for a long time that the individual sunspots have very intense magnetic fields, sometimes reaching an intensity of 5,000 gauss. When compared to the magnetic field of the whole sun which is about 50 gauss, the sunspot field is seen to be significantly large. In fact these magnetic fields of sunspots even affect atmospheric conditions on the earth! The problem arises when astronomers try to determine whether the magnetic field of the sunspot produces the outflow of gases or whether the outflow of gases produces the magnetic field.

III. Period

The period of sunspots shows that the sunspots are more than just a temporary pecularity of the sun. It is known that sunspots follow a pattern of reaching a maximum (relative number of observed sunspots) of about one every eleven and one-tenth years, though it may vary by plus or minus three years. It was not until 1851, however, that this cycle of sunspots was established by Schwabe, after long and intensive research on sunspot density. But from careful records of previous sunspot activity, a determination of the sunspot period has been established for the last 300 years. The method of recording the number of sunspots in a given period

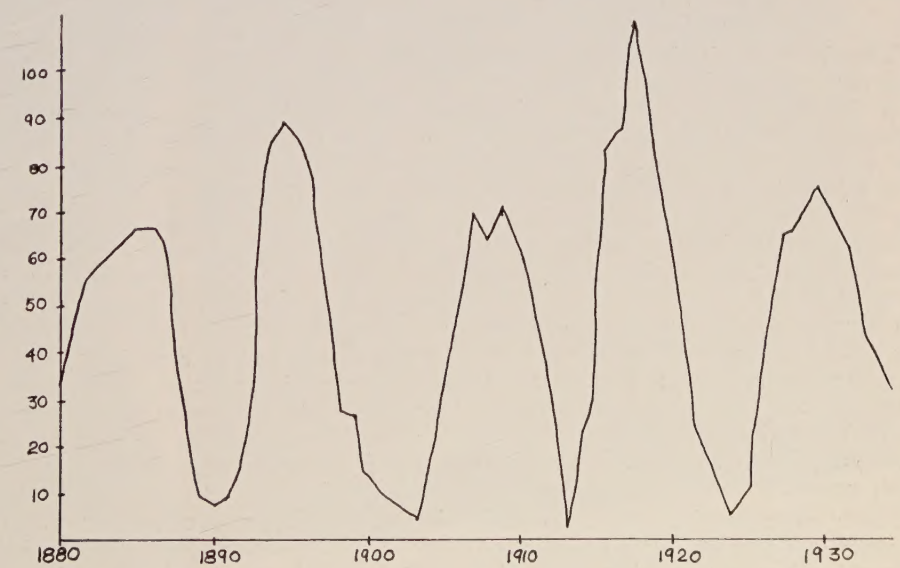


Figure 1

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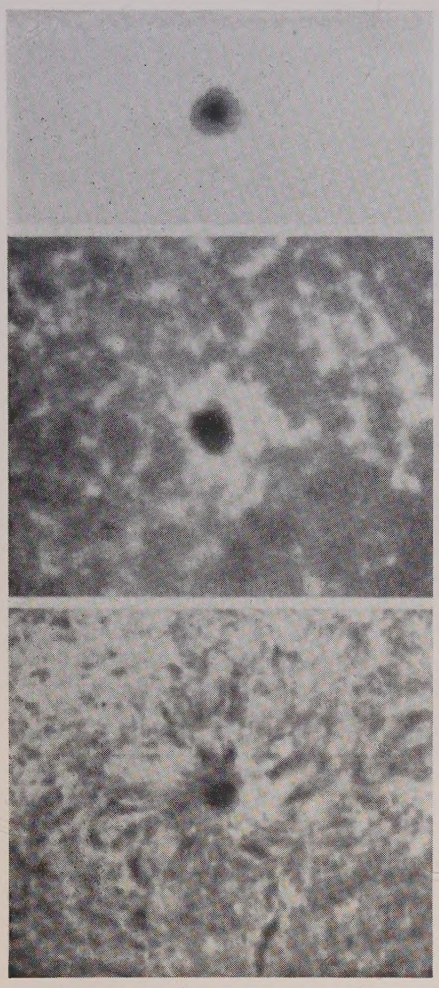

The three basic types of sunspots are illustrated above. From top to bottom they are: multi-polar, bi-polar and single pole.

of time was devised by Wolf after Schwabe's discovery of sunspot periodicity. Wolf invented an arbitrary method of determining the sun spot number n, designated by the formula below.

$$n = k(f + 10\,g)$$

The factor k, is dependent on the observer and the size of the telescope, g is the number of disturbed regions (groups or individual spots), and f is the total number of individual spots. The value of this method of determining sunspot activity is questionable because it does not relate exactly proportionally the number to the surface area occupied by the sunspots, and it places too much emphasis on small disturbances. The only reason that Wolf numbers are retained in preference to a more accurate type of determination is for their historical significance. The sunspot cycle, shown in Fig. 1 is based on Wolf numbers.

Yearly averages of sunspot numerical intensity give a much better periodic relationship than a monthly or weekly average would, because during a shorter period of time, the number fluctuates too much to give a readily noticeable period.

The life of the indivdual spot, or group of spots, is much shorter than the period of a complete cycle. In analyzing the life of a spot it would be best to see first how it grows, the path it takes, and how it disintegrates.

IV. Growth

The sunspot is an accumulation of small disturbances which grow to variable proportions. They range in size from spots as small as the intergranular spaces of the sun, to the maximum observed, which was 5,700 million square miles, seen in February, 1946. This may seem to be a large portion of the surface of the sun, but it is only one-half of one per cent of the visible solar surface. The Chinese, who recorded observations of solar pecularities in 28 B.C., were able to see the sunspot without the aid of optical instruments because spots larger than 25,000 miles in diameter can be seen by the naked eye.

V. Path

The path of the sunspot is similar to that of the storms on the earth. The sun, like the earth, is a rotating body, although being gaseous, it does not rotate as a single body. Instead, it is found, through the observations of faculae and sunspot motion, or by the Doppler Effect, that the equatorial region is rotating more rapidly than are the higher latitudes of the sun. But for all purposes the sun can be considered to be a rotating body, taking an average of 27 terrestial days for one revolution, and having an axis of rotation, an equator, and two polar regions.

Sunspots begin in the higher latitudes of both hemispheres, and move in a generally circular path from east to west, An interesting deviation from normal sunspots was discovered by Trouvelot in 1875. He noticed spots with no umbra sometimes located within 10 degrees of the poles. These spots were termed "veiled spots" because they appear to be partially buried by the solar surface. The regular sunspots never go above 45 latitude. Instead, it is observed that most sunspots have their beginning around 30 latitude, and grow very rapidly, usually attaining their maximum area within a week. During this growing period, the spot not only travels in a westerly direction, but it also slowly migrates toward the equator. The speed of the spot is rapid during the first two days of its existence—about one degree longitude per day. In the next two days it travels four tenths degrees per day, and on the twentieth day it moves about six-hundredths degress longitude per day. The maximum size is reached in the vicinity of fifteen degrees latitude. Each group of spots does not last for the same amount of time though. A spot may endure for only a few days before disintegrating, or it may last for months. The most enduring spot on record (1840-1841) remained a full 18 months. Although a spot grows rapidly, it declines at a slower rate. Near the end of a group's existence, the following spot begins to disintegrate, while the leading spot continues on. As the group nears five degrees, it completely disintegrates leaving only patterns of faculae.

VI. Groups

Mention was made in the previous paragraph of spot groups and trailing spots. In general, sunspots may be classified in three categories, according to the number and magnetism of a group. In the first category is the unipolar spot. This spot is alone and has a definite polarity. Because all magnetic substances have two poles, a magnetism of opposite charge, but still within the unipolar system, must return to the surface in some unspotted region. The end of a sunspot cycle is marked by an increased percentage of the unpolar variety of sunspots.

On the other hand, the second group —bipolar spots—is characteristic of the beginning of the cycle. The bipolar group is made up of two apparently individual spots traveling as a pair. The leading spot of this group is one complete spot usually larger and closer to the equator than is the trailer, which may be split into several components. The most significant fact connected with bipolar spots is that the two spots have opposite polarity. All through a complete cycle of eleven and one-tenth years, the leading spot of a bipolar group in one hemisphere will have a constant polarity, say positive. The following spot in that group will then have negative polarity. In the other hemisphere, the pattern is reversed; the leader will be negative, while the follower is positive. At the beginning of the following sunspot cycle more than 90 per cent of the respective spots of each hemisphere reverse their magnetic charge. It is for this reason of the change in polarity that some astronomers suggest that the true sunspot cycle may be of twenty-two and two-tenths years duration, rather than eleven and one-tenth. Of all the types, the bipolar group is the most commonly observed.

Finally, the multipolar groups— those groups made up of many spots, and having complex fields of magnetism—are very scarce. On the average, only one per cent of all the spots are multipolar.

VII. Theories of Existence

Many theories attempting to explain the existence of sunspots have been pro-

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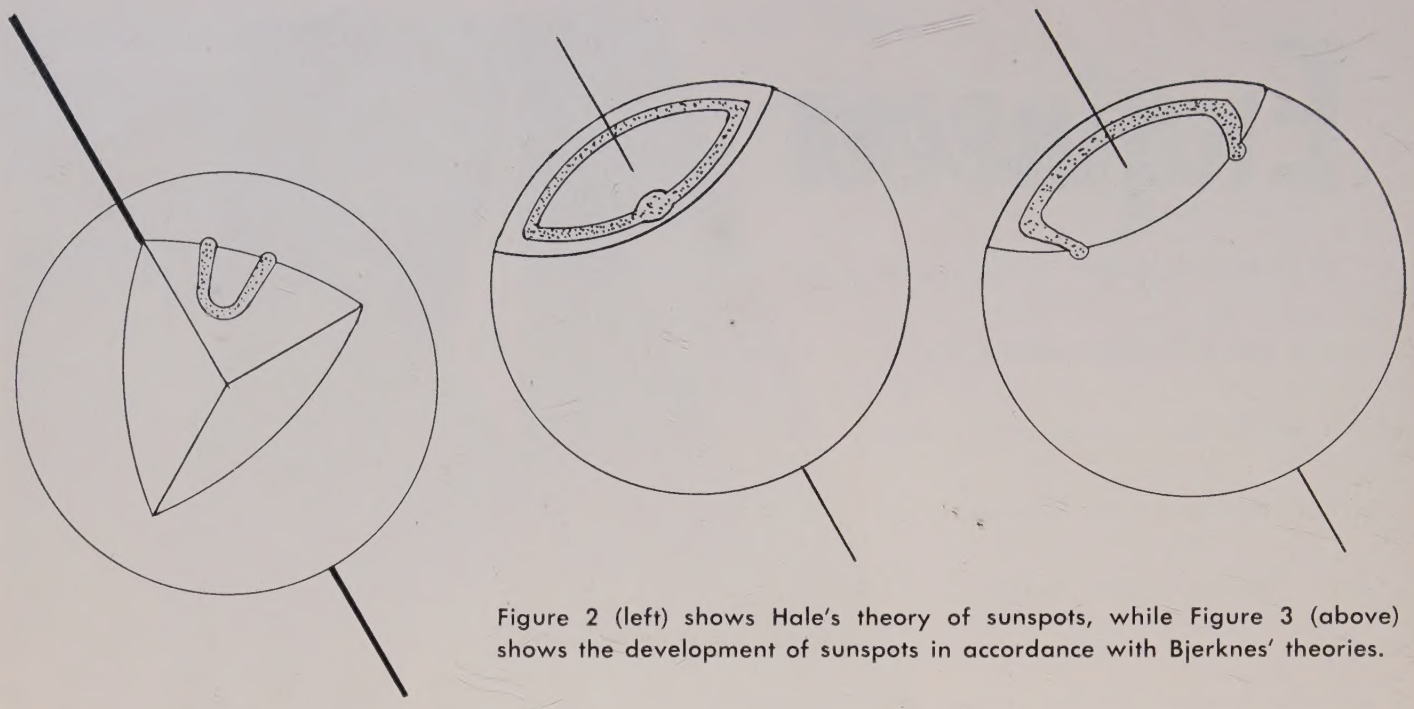


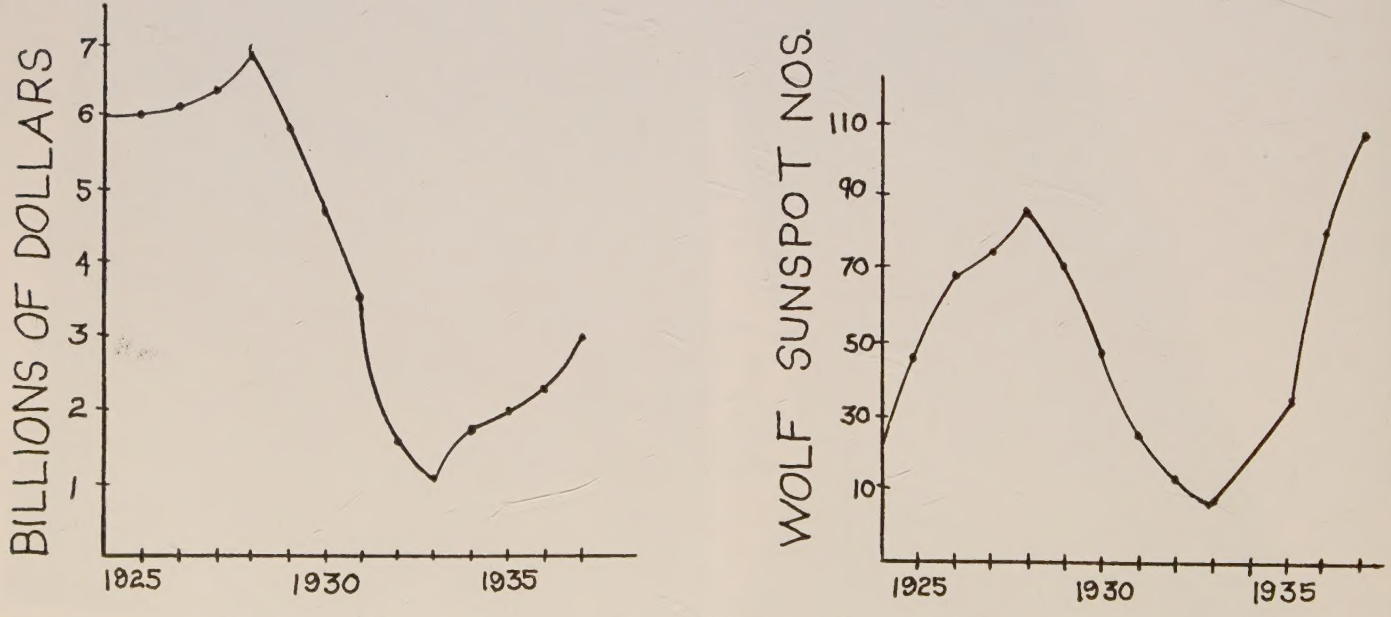
Figure 2 (left) shows Hale's theory of sunspots, while Figure 3 (above) shows the development of sunspots in accordance with Bjerknes' theories.

pounded. However, you may consider any of the theories given here, or come to your own conclusion about sunspots, for there is no way, yet known, of finding the complete answer to the existence of sunspots.

One of the early astronomers, G. E. Hale constructed the first vertical type fixed telescope. Robert Baker in his book "Astronomy" says Hale also set forth a theory of sunspots which "pictures the spot as the top of a column of very hot gas coming up from below the visible surface. As the gas rises it is whirling and the vortex motion of the electrified material produces the magnetism of the spot. As fast as the gas reaches the surface, where the surrounding pressure is reduced, it expands, and is thereby cooled, causing the dark spot." He imagined that the lower end of the gas column might rise to the surface form ing a U-shaped vortex. Figure 2 shows a sectioned view of the sun exposing the area of turbulent gases described by Hale.

Another astronomer, Bjerknes, also considers the hot whirling gases on the interior of the sun, but instead of being U-shaped, he thinks that they are circular, as shown in figure three.

As a disturbance breaks the ring, the two open ends migrate to the surface, where they appear as a bipolar group. The reason that astronomers think that sunspots are coupled, is due to the opposite polarity and contrarotation of a bipolar group of spots. Bjerknes thinks that there are two of these rings in each



BUILDING CONTRACTS SUNSPOTS

Figure 4

hemisphere which migrate to the equatorial regions. Both rings may have many outbreaks.

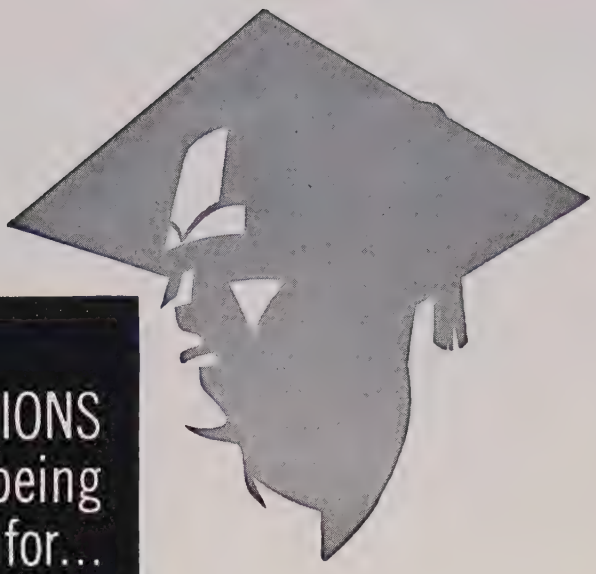
Two other popular theories exist, which consider a turbulent core area within the sun. Alfven, of Sweden, suggests that the sun has a turbulent, convective core which has magnetic properties. If a disturbance in the core occurs, the wave will be retransmitted to the surface, carrying with it some of the magnetic field. The other theory involving a turbulent core, proposed by another Swedish person, Walen, is very similar. He thinks that the pulses coming from the core are doughnut shaped, so that when the pulse reaches the surface of the sun, the resultant tube resembles Hale's description of coupled spots.

There are also theories attempting to explain the periodicity of sunspots. Some astronomers believe that the planets may have an effect on the period. If a group of planets were to all exert a force, similar to the moon's tide raising force, in the same direction, and at the same time, a sunspot group might result. Although the periodicities of the sunspots do not agree with the periods of revolution of the planets about the sun, this fact does not mean that the planets have no effect on the period of sunspots.

VIII. Effects

Although there is conclusive proof of only a few sunspot actions here on earth, some people believe that sunspots directly affect many more things on earth. One of the most acceptable of these proposed effects, has been the correlation between sunspot activity and tree growth. Professor A. E. Douglass has spent a portion of his life showing that tree growth, determined through the observation of tree rings, is greater in times of sunspot maxima. Other correlations between sunspot maxima and economics such as the stock market rise and fall or the number of building contracts let (shown in figure 4), may be left to the readers thoughts and feelings.

The very serious effect of sunspots—radio interference—is the major problem today. It is known that sunspots help to distort the ionosphere, and also to increase the amount of interfering microwave radio frequency radiation. For this reason, the United States Air Force has built and now maintains, an observatory at Sunspot New Mexico, solely for the purpose of acquiring more knowledge of sunspots so that radio transmission may be improved. But until a lot more useful information about sunspots is known, they will continue to be a curiosity to the astronomer, and a headache to the radio engineer.



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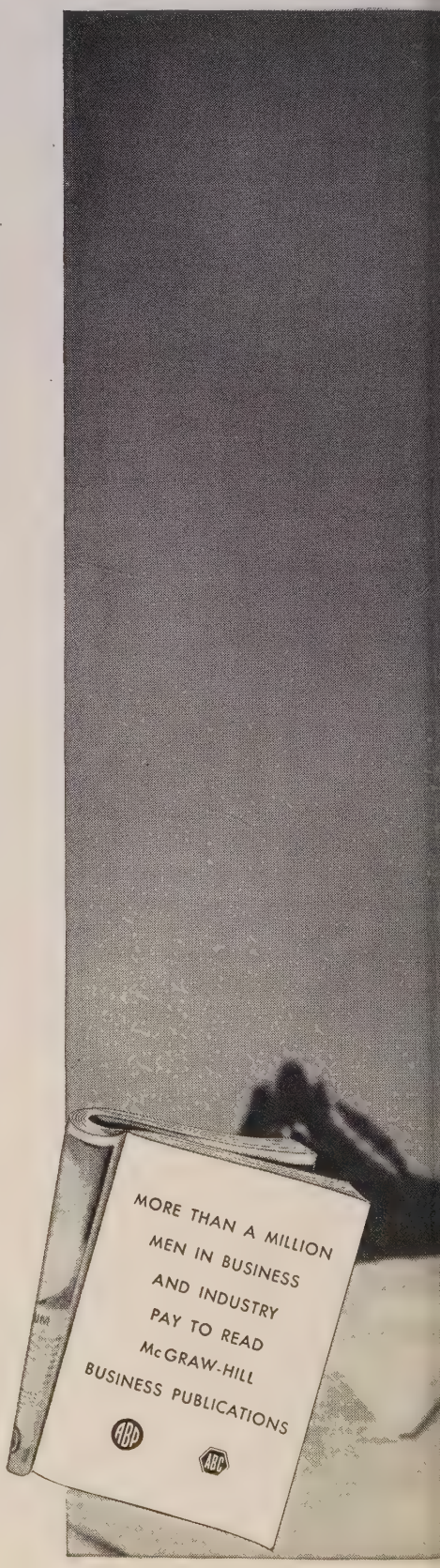

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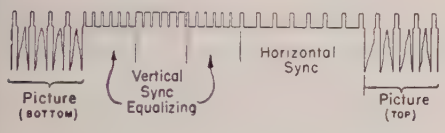
Color Television

here at last

by Phil Hicks, Ch. E. '59

Color television is here at last. You may wonder whether it is really here or not when you begin to pay for a set, but the fact that everybody cannot afford to buy a set right now does not make color TV any less present. It is here.

Only a few years ago, color TV seemed like a mere dream or something



(Fig. 1) A television signal is broken into these individual signals

that could only be on a Buck Rogers' Space Ship. Only a few years before that, black and white television seemed almost a dream. Now, from the listings of network programs in color and the attempts of TV manufacturers to drop the price of their color sets, it would seem that color is moving into the TV industry mighty fast.

One of the big questions always asked about a new thing like color television seems to be "How does it work?" This question is, of course, very broad, but the answer that most people are looking for with such a question is somewhat superficial. Let us look into the development of color television and its basic operation without 5,000 formulas, etc., to confuse everyone.

One of the first problems presented in developing color TV deals with the black and white sets now in use. A new system of televising color programs would render all the present black and white sets useless in receiving certain programs. Since no sponsor is going to present a full color program to a few individuals around the country who are lucky enough to have color TV, the color television system must be compatible i.e. the program must be received in both black and white and color. Thus, we have a limitation in developing the system before we start.

Since this article will not be concerned about B&W TV, it might be necessary to mention some very basic principles of scanning involved in TV receivers. See Fig. 6 during this discussion.

The screen of the CRT (Cathode Ray Tube) is coated with a substance which will light up or give off light when bombarded by a stream of electrons. An electron gun is employed at the back of the tube to supply the electrons. The gun or filament is a material which when heated throws off electrons. Next in line is the grid which controls the flow of these electrons. The grid might be thought of as a sort of traffic cop allowing only a certain specified amount of electrons to flow at one time (specified by the TV signal).

After the grid is the first anode or accelerating grid. By applying a constant voltage to this anode (positive since the electrons are negative-like charges repel, different charges attract, etc.) the electrons may be pulled through the grid and accelerated to high speeds. Now we have an electron beam, but it is crude and broad.

To refine the beam a focusing coil is used. It is an electronic lens functioning much as an optical lens. By applying repeling and attracting forces to the electrons the beam size may be controlled. With the beam refined and ready to work we want to scan it across

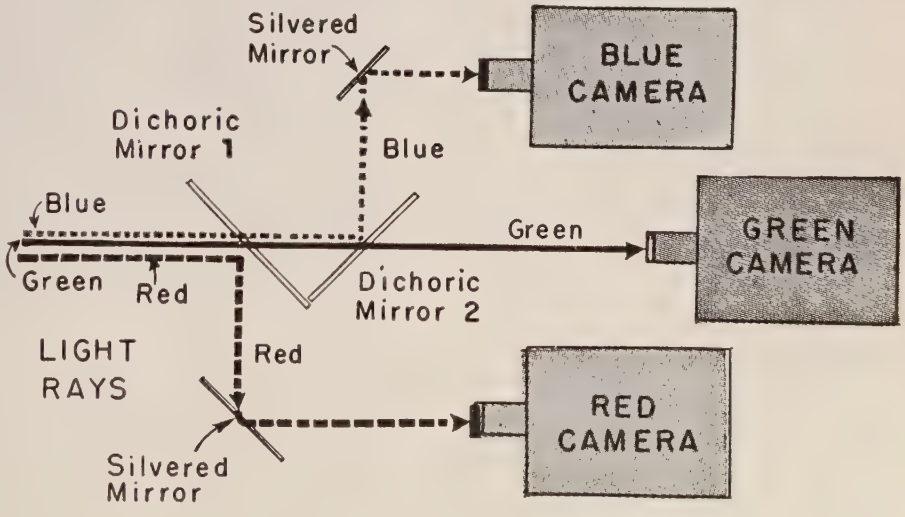


Fig. 2 shows how the dichroic mirrors combine transmission and reflection for three-color separation. (Photos and charts from TV Manual and Practical TV Servicing)

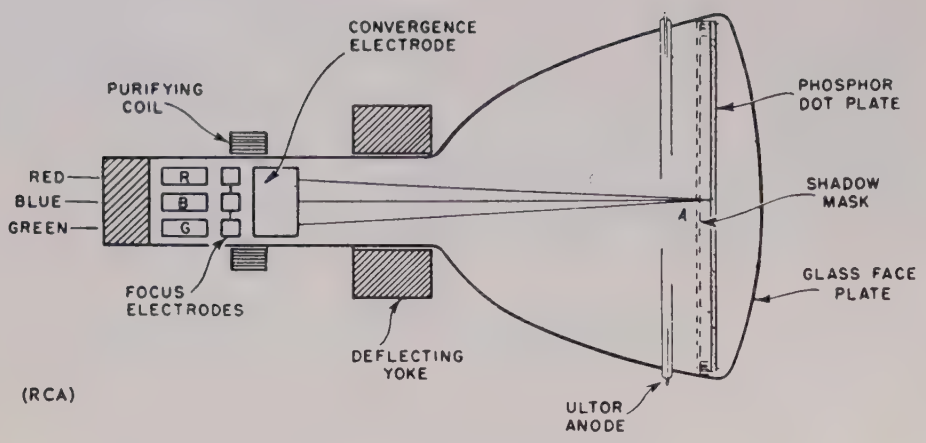
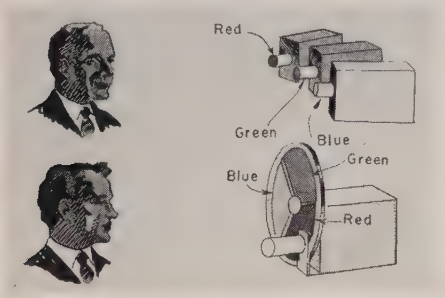


Fig. 4 illustrates the RCA "shadowmask" tube

and up and down the screen to actually paint a picture on the screen (painting the pictures at the rate of 30 per second).

A deflection coil will serve the purpose of scanning. By making the top of the coil negative with respect to the bot-



(Fig. 3) A colored wheel gives color images in the so-called mechanical method

tom, it can be seen that the stream of negative electrons would be deflected downward. In like manner, the beam may be deflected from side to side.

The scanning is now complete with only one more detail to bring into the tube. What to do with used electrons? The second anode is a coating of graphite inside the tube which is kept charged at very high potential. This anode attracts the electrons after they have hit the screen and served their purpose. If the used electrons were allowed to wander around the tube they would interfere with the electron beam and cause distortion in the picture.

The above short explanation of scanning may be kept in mind whenever scanning is mentioned in this article. When the three gun color tube is spoken of, there will simply be three separate scanning systems. (If the reader is not familiar with scanning, close observation of a TV screen in use will allow the lines to be seen. By varying the intensity of the line across the screen to correspond to the picture being taken by a camera, a full picture may be reproduced.)

Since color TV must comply with B&W TV standards, let us look at black and white for one moment. The standard B&W set has 525 scanning lines being scanned to give 30 pictures per second. This principle is much like that of a movie camera flashing, say 24 pictures per second. Actually, the TV set will give the effect of 60 pictures per second because the odd numbered lines are scanned alternately with the even numbered lines.

Next, the black and white signal is confined to a six megacycle (6,000,000 CPS) band width. Although this number sounds large, it is very small in width. The television signal may be broken into many individual signals. A portion of these signals may look like Fig. 1. Fig. 1 gives an idea of some of the information which must be transmitted to a TV receiver. In this signal will have to be included the information for color transmission. Since the B&W signals do not fill the band width, the color information may be included among the B&W signals. Just how information is included within the black and white signal band could lead to much explanation and complicated theory of transmission. However, we may discuss how the information is acquired at the TV camera and then reproduced again at the receiver.

An average person may distinguish about 150 different colors or hues in a picture. Obviously, 150 different transmissions of different colors would be very impractable. Mother Nature must have known color TV would come some day because she has given us a very convenient combination of colors. By mixing red, green, and blue in right amounts, (the standards adopted by the TV industry is 30% red, 59% green, 11% blue) white light is produced. White light contains all other colors and combinations of colors. This principle is demonstrated by white light passed through a prism and "broken" up into component colors. It can be seen then, that if all pictures or scenes could be broken into the three colors: red, green and blue, they may be mixed again to obtain the original scene in color. This is exactly what is done in color TV. The difference in color TV systems is mostly in the way employed in breaking up the picture into basic colors and recombining them again at the receiver.

There are very many ways of accomplishing the separation of colors. As a result, many color systems have been developed. Justice could never be done to all the types of systems of color separation in this article or many others like it. Although many systems may or may not be better in some ways, this article

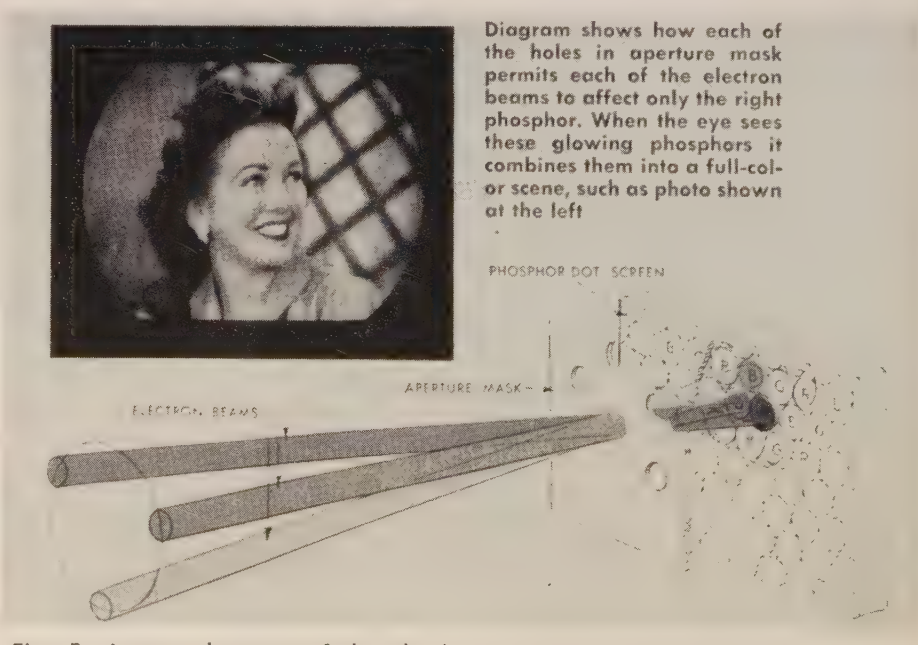
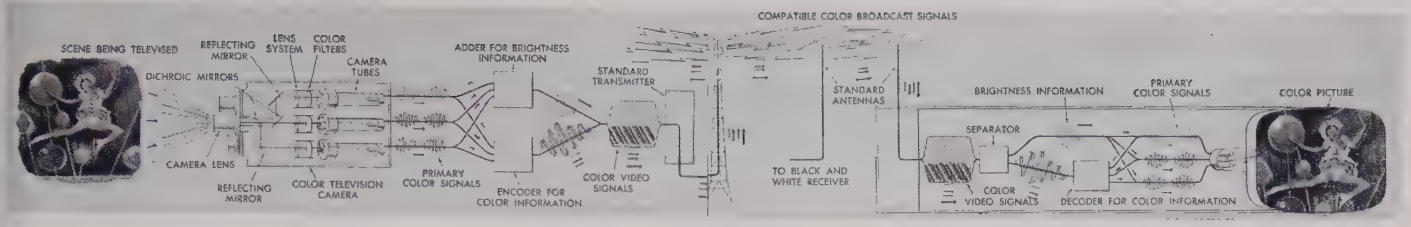


Diagram shows how each of the holes in aperture mask permits each of the electron beams to affect only the right phosphor. When the eye sees these glowing phosphors it combines them into a full-color scene, such as photo shown at the left
PHOSPHOR DOT SCREEN
APERTURE MASK
ELECTRON BEAMS

Fig. 5 gives a close up of the shadow mask and the phosphor dot plate used in the tube.

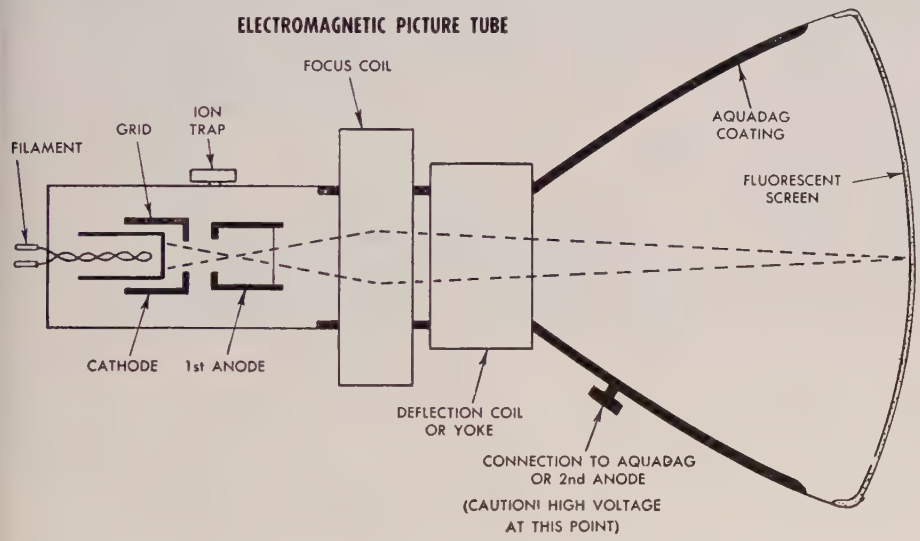


(Fig. 7) The RCA compatible color system is shown

will be concerned about the two types of color separation in use in the United States today. Mainly—mechanical and electronic.

The electronic system uses mirrors to separate the basic colors. The system may be seen in Fig. 2. Mirror one will pass blue light and green light but will reflect red, while mirror two passes green and reflects blue. Three cameras are used to intercept the three basic colors of the scene. It may be noticed that the red camera and blue camera are closer to the mirrors than the green camera. This is to allow the red, green, and blue light to travel the same distance and given an even distribution of light. From the three cameras then comes the information for the color telecast.

The other method in use is mechanical. This method is shown in Fig. 3. By passing a colored wheel with filters for the three basic colors in front of the TV camera, a color sequential signal may be acquired (the red, green, and blue components of the scene are taken during the period the corresponding filter is in front of the camera. Other than the color wheel, the system is much the same as black and white). The resulting signal differs from the electronic in that the electronic has three continuous color signals while mechanical color separation gives a signal with the basic colors trailing behind one another. It can easily be seen then that all that would be required for reception of a mechanical color signal would be a color wheel at the received synchronized to the one at the camera.



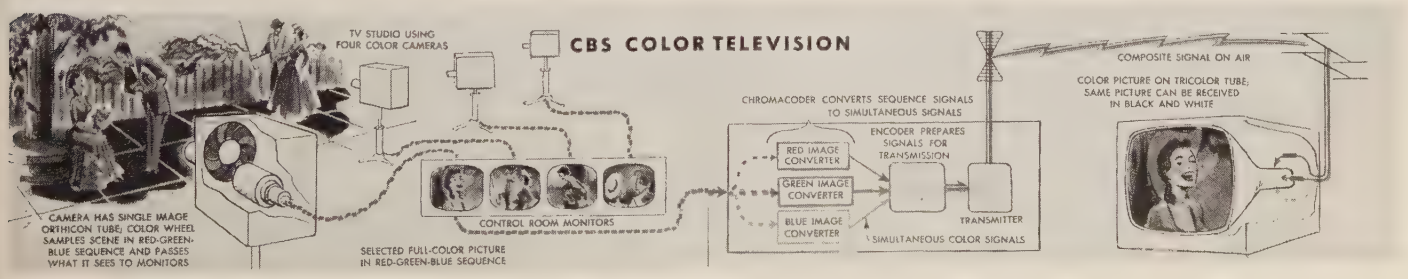
(Fig. 6) Basic black and white TV principles are illustrated in this electromagnetic picture tube.

A wheel big enough for a TV screen at the received would be rather bulky. Other problems would involve wheel synchronization and light loss by passing light through filters. After long debate, the FCC has adopted the electronic system with three continuous signals for *transmission*. However, the mechanical method of color separation is used in TV studios and then converted to three continuous signals by CBS. The electronic system is the method developed by RCA. So, we have two methods of breaking a scene into the basic colors for transmission. There the difference ends. From the transmitting tower to the receiver all color TV is the same (three continuous signals).

The combining of the three colors at the receiver is somewhat more complicated than breaking up the colors. The only sets on the market at this time use what is called the "shadowmask" tube developed by RCA (Fig. 4). A close-up of the shadow mask and the phosphor dot plate is shown in Fig. 5.

On the phosphor dot screen three types of phosphors are used. Each type gives one of the basic colors when struck by an electron beam. The dots are arranged in triads as shown. With three electron guns for the three colors each dot lights to give its proper color. The three dots are so close together that they appear as one and the eye combines the combination of the three dots into one resultant color.

The average color screen has about 600,000 dots since more dots give more and better detail. Placing 600,000 dots of phosphor on a screen and then hitting each dot with the proper electron beam could be hard to do. It can already be seen why a color tube is so expensive. To enable the right electron beam to hit the right dot, the idea of the shadow-mask was developed. Looking at Fig. 5, there is one hole in the mask for each triad. When the three beams go through this hole each beam can hit only the proper dot. Any tendency for a beam to hit or overlap another dot would be discouraged by the mask. Of course, placing the mask so that each hole is behind the proper triad is no simple job and will consequently


TV STUDIO USING FOUR COLOR CAMERAS
CBS COLOR TELEVISION
CAMERA HAS SINGLE IMAGE ORTHICON TUBE; COLOR WHEEL SAMPLES SCENE IN RED-GREEN-BLUE SEQUENCE AND PASSES WHAT IT SEES TO MONITORS
CONTROL ROOM MONITORS
SELECTED FULL-COLOR PICTURE IN RED-GREEN-BLUE SEQUENCE
CHROMACODER CONVERTS SEQUENCE SIGNALS TO SIMULTANEOUS SIGNALS
RED IMAGE CONVERTER
GREEN IMAGE CONVERTER
BLUE IMAGE CONVERTER
ENCODER PREPARES SIGNALS FOR TRANSMISSION
TRANSMITTER
SIMULTANEOUS COLOR SIGNALS
COMPOSITE SIGNAL ON AIR
COLOR PICTURE ON TRICOLOR TUBE, SAME PICTURE CAN BE RECEIVED IN BLACK AND WHITE

(Fig. 8) CBS has its own version of color TV transmission

raise the price of the tube even more.

By adjusting the three electron guns in the tube to scan its color dots properly, a clear and pure picture may be obtained. Now, let us tie the whole system together.

At the studio, the scene being televised is broken into the three basic colors red, green, and blue by either mechanical or electronic methods. The information for the colors is transmitted as three continuous signals. At the receiver, the set applies the red signal to the red gun, green to green, and blue to blue. The three colors of each triad are so small that the viewer sees only one resultant color. The individual dots combine to give a full color picture corresponding to the original scene. (Figs. 7 and 8 present the systems in diagram form). It appears that the color problem is solved, but what about black and white?

Color signals must carry information of hue and saturation (to explain, saturation is the dilution of the color, i.e., pure red with no other color in it could be said to be 100% saturated). This is controlled by being sure that the right electron beam hits its proper dot. Hue is the brightness of color as bright red vs. pink. This color information is of course not a requirement of black and white pictures. Therefore, just the brightest portions of the three color signals may be taken and mixed to obtain a picture for black and white transmission. Hue and saturation can be omitted for black and white purpose.

The color system is now complete. It suits every requirement and is completely compatible, that is:

1. Color signals can be received in color.

2. Color signals can be received in black and white. In addition, black and white signals may be received on the color sets in B&W.

Everything sounds perfect, but one might ask—"does it really work? Well, the answer to this question is—see for yourself. If you want to be really technical you could say no, not perfectly. If you want to enjoy color pictures on TV then you can say yes. All of the colors that one sees on TV are not necessarily what they appear to be. For example, one may see a green tree which is actually blue. Technically, the tree is being shown as blue, but the viewer is incapable of distinguishing blue from green to some degree and will accept the blue tree as green. This is not to say that all green is blue on TV, but only that such a thing may happen. On a set that is properly adjusted, the viewer can depend on a true full color picture. Does one need to be an engineer to properly adjust a set?

Other than for installation and adjustment of the set, there are only two additional controls for color reception. They are hue and saturation. If the viewer knows whether he likes his colors bright or dim and how he likes flesh tones, then he is all set. Usually, a color receiver is simple to adjust by paying attention to flesh tones. Other colors will balance relative to the flesh tones.

One last question probably arises, "Can my B&W set be converted to color?" The answer is yes, depending on the individual. If a person can follow a schematic diagram, he may be able to convert his B&W set. The three continuous signals may be conveniently changed into a color sequential signal and used with a color wheel in conjunction with a B&W set. The conversion is relatively inexpensive and shall probably be covered by a later article on color conversion.

Avoiding the question of conversion, however, it can certainly be seen that color TV is making a place for itself in the world today and soon will play a big part in the everyday lives of many people throughout America and all over the world.

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Forgotten Genius . . .

Nikola Tesla

by Rick Van Weelden, M. E. '60

Did you ever hear of a man named Nikola Tesla? Probably not. Considering the fact that many people rise to fame because of only one invention or development, it is amazing that such a prolific inventor as Tesla is almost entirely forgotten.

Nikola Tesla was one of the many Europeans who found success in America. He was tall, suave, and impeccably dressed. He was six feet two inches tall and weighed 142 pounds. His perfect English added to the air of "continental charm" which was so popular in that period of 1890 to 1900.

Although he was undoubtedly a genius in mathematics and science, he had absolutely no money sense. When he had large amounts of money he spent it very fast, and in many instances extravagantly. For example, he insisted on a new pair of white gloves each and every week.

Another interesting characteristic was that he had a highly developed sense of mental visualization plus a photographic memory, with the result that he very seldom made blueprints or notes about his work. This was unfortunate, because many of his undeveloped inventions will never be known.

Nikola Tesla was born on the stroke of midnight between July 9 and 10, 1856. This event occured in a rural region near the Adriatic Sea, in what is now Yugoslavia. His father was a minister of average ability, but his mother was quite brilliant. Because of this, Tesla attributed his inventive abilities to being inherited from his mother.

Young Tesla began his education at the age of four, when he entered the Normal School. From there he went to the Real Gymnasium when ten years old. After four years there, he went to the Higher Real Gymnasium in the town of Karlovac, in old Croatia. There he completed four years work in three. He now had the equivalent of a high school education.

A serious sickness and getting himself exempted from the draft helped to consume an additional year after graduation. At the end of that time Tesla entered the Polytechnic Institute in Gratz, Austria. It was during his second year there that he decided the direct current system of electrical production, transmission, and utilization could be improved upon.

After completing his four years at Gratz, Tesla worked for a year to save some money. He then went to the University of Prague for a year for additional work in mathematics and physics.

Tesla started his career as a draftsman for the Central Telegraph office of the Hungarian government. His job was perhaps one of the first created by the telephone. This happened because the telephone was being introduced to Europe and extensive developmental work was going on. It was in connection with this work that Tesla was hired.

Tesla did not stay long on the job, however. His superior ability was soon noticed, and within a few months he was put in charge of the new telephone exchange in Budapest. Much of his work there consisted of devising new and improving upon existing equipment. Therefore, this could be considered his first job as an inventor and developer of new devices.

It was shortly after he started working that Tesla evolved his first major idea. While walking through one of the city parks with a friend, he received a stroke of inspiration which

Tesla as a young man

crystallized the answer to the problem that he had been working on for more than five years. On that fateful afternoon in February 1882, Nikola Tesla devised the basis of alternating current power as we know it today: using two or more phases of current to produce a rotating magnetic field in the motor.

Although he already knew the ability of a. c. to change voltage and current values, this was secondary to the actual electrical - to - mechanical energy conversion aspect. The main reason was that at the time electricity was used mostly for power because the lights of that period were too poor to receive widespread acceptance.

Within the next two months Tesla worked out designs for generators, motors, and everything in between.

The sale of the telephone station where Tesla worked resulted in his dismissal. However, one of the executives gave him a good reference which Tesla used to obtain a position with the Continental Edison Co. in Paris. While in Paris he talked continuously about his invention, but neither the company nor anyone else showed any serious interest. That, plus the fact that the company refused to give him some money that was rightfully his, caused him to quit.

By this time Tesla was 27, full of ambition, but out of a job. Therefore he decided to come to America where there would be more opportunities and possibly a chance to develop his invention. One of the officials of the company gave him an introduction to Thomas Edison, so at least Tesla was reasonably assured of obtaining a position when he arrived here.

When Tesla stepped off the boat in New York his financial resources totaled four cents. Therefore he did not waste any time in going to see Edison. The letter of introduction was enough to obtain a job, but it was apparent that there were going to be differences of opinion. For one thing, Tesla was a careful scientist who made all calculations before any work was started, whereas Edison was more of a hit-or-miss experimentor. More important at the time, however, was the fact that Tesla was naturally an advocate of his a. c. system, but Edison was convinced that direct current was the better, and neither of them would yield to the other.

Tesla was not too happy in his job, so he resigned in the spring of 1885, less than a year after he started. He decided that he wanted to work for himself, so he started his own company. For about a year he worked on designs of arc lighting systems, mostly because that was what his backers wanted. Then he was forced out of the company by financial maneuvers which he didn't understand. At the time, the country was in the midst of a depression, and jobs were almost nonexistent. Consequently, Tesla had to go to work as a common laborer, earning $2 per day. For Tesla this was pure misery.

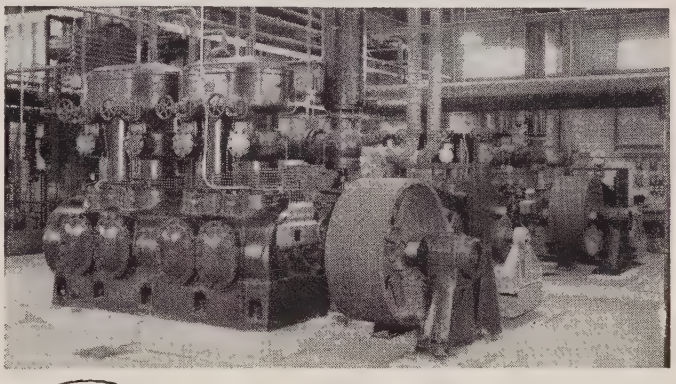
Finally, however, he managed to obtain some financial backing, and in April of 1887 he organized the Tesla Electric Co. He opened a lab on what is now West Broadway in New York City and started constructing his polyphase power system. Because he could visualize everything as if he were actually seeing it, he didn't even have to take the time to make drawings of the different parts. He soon had a full sized power system operating in his lab.

Before a year had passed the Patent Office issued to the Tesla Electric Co. seven basic patents virtually covering the entire field of a. c. This event was widely reported among the electrical engineers and technical societies of that time, and he was invited to speak before the A.I.E.E. He accepted, and on March 16, 1888, delivered an explanatory lecture on his polyphase system which was heralded as a classic in the field of electrical engineering.

Naturally, Tesla felt greatly honored by the recognition suddenly given to him. However, the results were far more important than the recognition itself. About a month after the lecture George Westinghouse appeared at the lab. After a short demonstration of the polyphase system, the two men got down to business. Five minutes later the deal was closed. Westinghouse bought all of Teslas a. c. patents for $1,000,000. There were 40 patents in all, most of them very basic, so the actual purchase price amounted to $25,000 per patent, a very reasonable sum. Nevertheless, Westinghouse had the patents, and the Tesla Electric Co. had $1,000,000, of which Tesla himself got half. Furthermore, he was put on the Westinghouse payroll for a year to act in an advisory capacity while the development of commercial units was going on.

By the end of the year Tesla was anxious to resume his experimental work. He had been unable to do any during his stay at Westinghouse but his mind had kept producing new ideas. Most of these problems were worked out and "mentally blueprinted," so all that had to be done was construction of the models.

When he returned to the lab. he attacked a hitherto unexplored field: high voltage, high frequency current. One of the devices that he invented was the Tesla coil, essentially an air core



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P.S. In case you *didn't* identify the equipment shown above, it is part of an 8 ft. Sperry-designed radar antenna for long range missile guidance.

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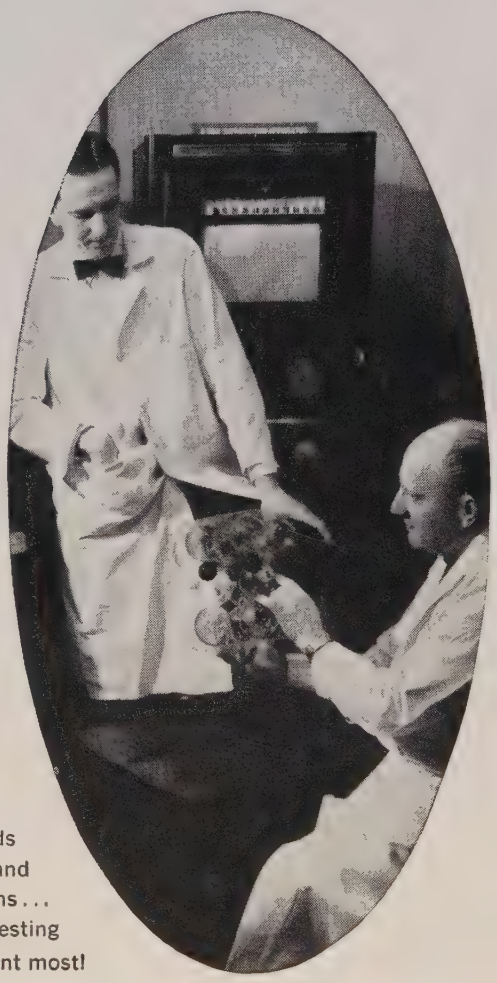

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transformer used to produce extremely high voltages. These currents had many peculiar characteristics. For instance, we usually consider copper to be a conductor, and air an insulator, but in the case of high frequency currents the opposite is true. Another fact is that these currents are harmless to the body, mostly because the nerves cannot react quickly enough to transmit any pain or heat sensations.

Many of these strange properties, and many more, were explained by Tesla in a second lecture before the A.I.E.E. in February 1891. He was soon invited to give the lecture before technical societies in both Paris and London, and he accepted the invitations. That any man should give two lectures before such a group as the A.I.E.E. on two entirely different and unknown subjects, within 3 years of each other was regarded as being evidence of a genius of unlimited abilities.

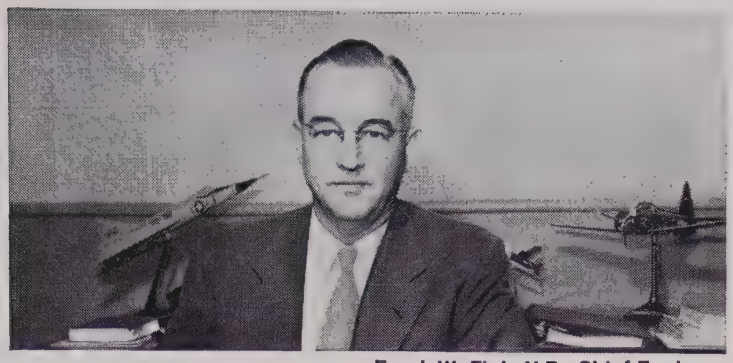
During the same period Tesla did some experimenting with mechanical vibration. However, these experiments weren't very popular with the inhabitants of the surrounding neighborhood, because one day he bolted a vibrator to the frame of the building and literally almost shook the neighborhood to pieces. The police down the block thought that an earthquake had come until they remembered Tesla. Then they made sure that there would be no more experiments of that kind again.

In May of 1899 Tesla went to Colorado to continue his work with high voltages. His apparatus was getting to the point where the tremendous voltage could no longer be confined in his regular laboratory. Therefore, when he arrived in Colorado he had a new laboratory built in which the main room was 100 feet square. Within this room was housed a giant version of the Tesla Coil. The secondary coil was ten feet in diameter and ten feet high. It was connected to a three foot spherical copper electrode atop a 200 foot high tower. The primary consisted of several turns wound around a framework that was eighty feet in diameter. The whole apparatus produced sparks that were 135 feet long, equivalent to about one hundred million volts at one hundred fifty kilocycles.

Tesla's ultimate goal was wireless transmission of power over a distance of thirteen miles, at what he claimed was 95% efficiency. However, there were never any large scale experiments along this line, mostly because of insufficient finances. After that, Tesla's accomplishments were slow in coming.

Nikola Tesla lived until 1943, when he died at the age of 87. There was very little notice of the event. The genius was forgotten.

"What do you need for a successful engineering career?"



Frank W. Fink, V.P., Chief Engineer

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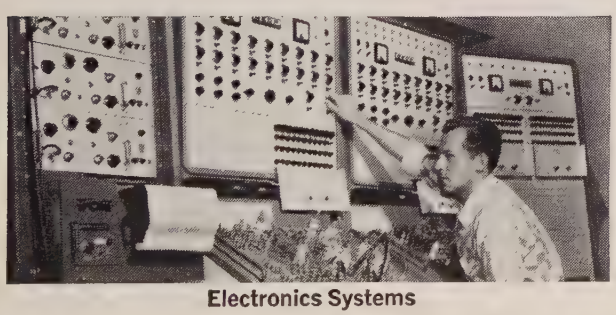
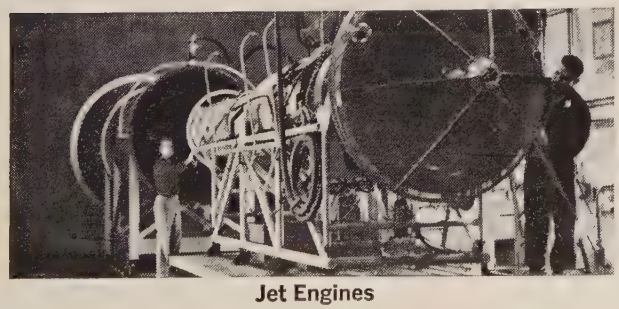


Electronics Systems



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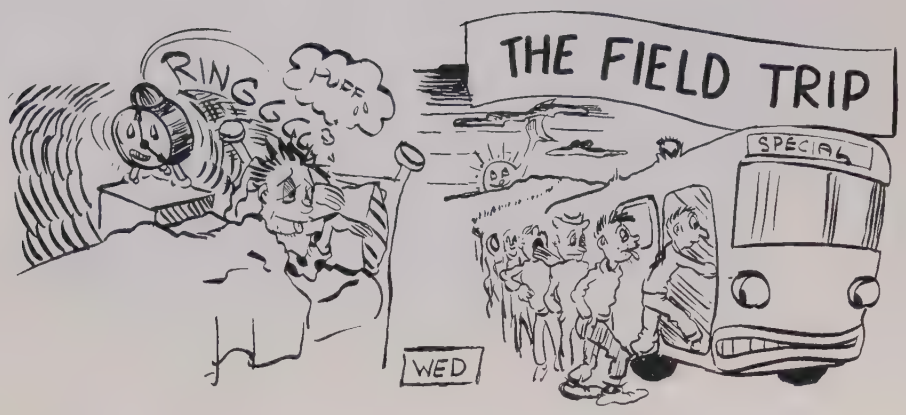


Engineering 299 . . .

INSPECTION TRIP

by Harry Hirsch, E. E. '57

One of the prerequisites for graduation from the College of Engineering of the University of Illinois is participation in the senior inspection trip—Engineering 299. The inspection trip is an annual event in the fall semester in which graduating seniors travel about the Midwest, seeing various examples of industry in their chosen field. In the words of the inspection trip guide: "Inspection trips are required because it is believed that the educational advantages resulting from the inspection of large industrial enterprises fully justify the time and expense involved. To realize this ideal, however, students must use every endeavor to secure a correct impression of the places visited, an appreciation of the general nature of the plant inspected and of its product, rather than of minor details."

As the attached box shows, at least a dozen trips were made to satisfy the needs of different branches of engineering. To try to describe each trip in any detail would be folly beyond listing the stops. If one trip is described, the danger of overspecialization is possible. Does a mechanical engineer wish to read about the trip an electrical engineer takes? In most cases, no. But for the high school student interested in engineering and indeed, freshmen and sophomore engineer students, one inspection trip is as good as another. They all have common details. It is with this view in mind—that of describing what one inspection trip is like—that this article is written. Most articles in this magazine as with engineering reports, are written in an impersonal style, but for once in an effort to better describe the trip, a personal narrative style will be used.

Inspection trip started off routinely enough and quite early for all February and June 1956 graduates of the College of Engineering. We registered for the trip as EE 299, IE 299, ME 299. The course name varied, but it always had the 299 suffix-inspection trip. No credit hours are given, but it is necessary to register for the trip. The next step was the payment of the bus fare, in our case, $10 for the charter bus trip to Chicago and Milwaukee as members of the Power Option-Electrical Engineering group. There was a group of EEs in Illumination Option and another in Communications. Each group had different destinations.

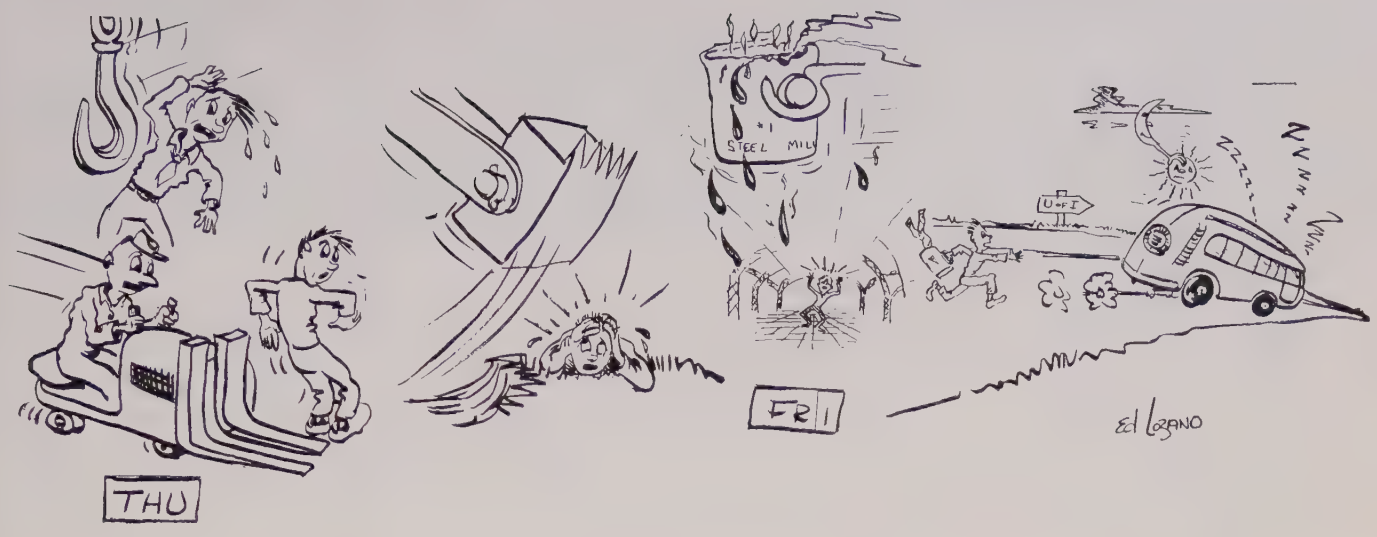
The inspection trip for each department was to take place during the week of Oct. 15. Some groups left Monday and returned Friday. Others left Wednesday and some left Thursday. Each group was to meet Monday, Oct. 15, in the afternoon for a briefing on the trip. Booklets containing our itineraries and those of other departments were handed out, along with instructions on dress, hotel accommodations (reservations were made in advance) and plant behavior (don't touch machines, products or girls). Any questions were answered promptly. We were told to meet at 5:45 a.m. Wednesday morning in front of the Electrical Engineering Building.

Six buses left Wednesday morning. Five were for the Communications Option people and one was for the Power men. The Illumination majors, numbering only six went by auto. Our bus contained 28 seniors, from Acostacarbonell to Zola, two graduate students and two faculty members—Prof. Charles A. Keener and M. S. Helm. We left on time, in murky pre-dawn blackness. Our first strop was at the Greyhound Post House at Onarga, Ill., about 85 miles from Chicago.

This was a brief stop for stretching the legs and coffee for those who had missed their breakfast and we were soon on the road again, calling after the Communications seniors who had just entered as we left.

By 9 a.m. we were rolling in the suburban morning rush hour traffic south and west of Chicago and arrived at the gates of Western Electric's Hawthorne plant in Cicero promptly at 9:30 a.m.

We were quickly taken to a demonstration room in the plant, given a short briefing on Western Electric's crossbar dialing switching system and divided into groups for a tour of the cable plant and rod-wire mill. In this tour, we saw copper ingots, heated and stretched from 250 pound bars of about three feet long and one foot in diameter to rods, 1,100 feet long and ¼ inch in diameter. We followed these through mills where they were futher stretched, coated with insulation, chemically treat-



ed and then bound together as cables, video cables, coaxial cables, you name it.

After our tour, we were taken to the company dining room for 11:30 a.m. lunch. We remained in small groups of five or six, with a Western Electric representative at each table to hash out informally details of our trip and the company in general. Incidentally, we were served an excellent meal of filet mignon. As we left, we were presented plastic brief cases, containing material on the operations of Western Electric and a special issue of their plant newspaper, *The Microphone*, especially published for our visit and that of communications majors later in the day.

From Hawthorne, we proceeded around Chicago's west and south sides to the Wisconsin Steel Co. plant of International Harvester on Chicago's far South Side. Although this was only the start of the trip, some of the crowd complained of sore feet already. The day was ideal for traveling, warm and sunny, but through the steel plant we had reason to regret the heat.

Arriving slightly after our scheduled time of 1:15 p.m., we were given safety goggles at the entrance, a practice followed by every industry we visited. We were then taken on a tour of the plant's coke ovens, where coal is made into coke for the steel and iron production. We next visited the open hearth furnaces, where coke, limestone, iron and scrap steel were mixed in huge furnaces and poured out as molten steel. The scene, confused (to us), grimy, dark and huge, resembled Dante's inferno. Yet those who worked there knew what they were doing. It seemed uncoordinated, but the steel poured when they wanted it, where they wanted it and no accidents occured. Our next stop was the power plant where AC electric power, bought from Commonwealth Edison Co., is converted to plant power needs and DC generators powered special needs. Following the power plant, we visited the blast furnaces, where iron ore is made into molten iron. Here we saw the metal pouring out of the huge oven, running through troughs in the floor like a river of fire and falling into other buckets outside the furnace enclosure. We then journeyed to mills where the iron and steel were made into ingots after cooling and pounded, stretched and rolled into shape by huge presses. Ribbons of hot steel where whipping around, dextriously handled by skilled workers. Our final stop was the plant where the steel bars were treated prior to shipping, with impurities being stripped off.

The group reassembled at the bus and we left at 5 p.m. bound for Milwaukee. We arrived in Milwaukee about 7 p.m., having gained an hour in the change from Daylight to Standard time. Our hotel was located about two miles from downtown Milwaukee, and a few blocks from the Marquette University campus. We were free until 7:45 a.m. the next day, but many weary feet quickly went to their rooms.

The more hardy individuals, after freshening up, left the hotel on a multitude of errands. Some for pre-arranged rendezvous with local members of the opposite sex, and some to sample the product that made Milwaukee famous. Some walked or rode downtown to see the sights and shows or sample Milwaukee's fine food. On the way back we dropped in at Marquette's fine Student Union Building, a recent campus addition, designed in a modern, yet quiet and friendly astmosphere. Later in the evening, many met with the stay-at-homes in the hotel's lounge for a quick night cap before bed and a discussion of the day's events.

The next morning came early, too early, as we were called by the desk at 6:30 a.m. for breakfast before leaving for Allis-Chalmers Co. We left at 7:45 a.m. arriving about 8:15 at the Allis-Chalmers plant in West Allis. We were given safety goggles and assigned into groups and entered the plant. We toured the foundry, pattern shop, machine shops and erection shop, but the trip took much longer than that to relate. Castings up to 135 tons have been poured in the pit area of the foundry. We saw a test setup simulating a transformer to be tested for a three million volt lighting bolt, and saw transformers of up to 500,000 pounds in the transformer facilities area. The main erection floor is 1,250 feet long and four stories high. We traversed it twice, seeing equipment being assembled for a 300,000 kilowatt generator for Detroit-Edison Co., the largest steam generator in the world. We saw a huge 40 foot vertical boring machine, turbine bladings of 1/1000 of an inch tolerance, rock crushers, generator and synchronous motor rotors being slotted for windings, a 2,500 ton press in the forge shop, and drop hammer of up to 8,000 pounds force.

Yet these are mere words. Allis-Chalmers is big, big, big. After our walking tour, we returned to the Allis-Chalmers Clubhouse outside the plant for lunch and met a party of UI General Engineers who were scheduled to tour the plant facilities in the afternoon. Their visit was to include the tractor plant which we hadn't seen. Lunch here was an excellent beef goulash with noodles.

We left at 1:45 for a tour of Wisconsin Electric Power Co.'s stores and equipment building on Milwaukee's West Side. Our tour was originally to see the Wisconsin Electric Oak Creek Power Plant, newest in the system with three 125,000 kw units, a turbo-generator unit and a fourth to be installed. Our itinerary was changed, however, to

(Continued on Page 42)

Success is a journey...

At Wisconsin Electric Power Company, success is a *journey* . . . not a *destination.* Since all of our engineering work is performed by our own engineers, each step along the way is marked with the kind of opportunities that breed success.

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You will find working at Wisconsin Electric Power Company a very satisfying experience because most of your time will be spent on actual engineering problems. For example, you may be engaged in designing and building power plants, substations, transmission and distribution lines. You may be called upon to solve a wide variety of chemical engineering problems.

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If you have a desire to put your education to work and to keep on learning . . . success is bound to accompany you every step of the way in your Wisconsin Electric Power Company career. We cordially invite you to find out more about the many advantages we have to offer *you.*

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Find out more about career opportunities at Wisconsin Electric Power Company by picking up a personal copy of the interesting booklet, "You and Your Future" now available at your Placement Office. At the same time, check the interview schedule for dates when our representative will be on the campus.

WISCONSIN ELECTRIC POWER COMPANY

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. . . in the field of INSTRUMENTATION

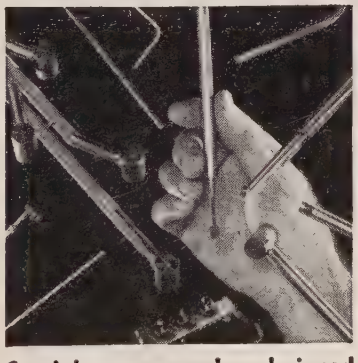
Among the many engineering problems relative to designing and developing today's tremendously powerful aircraft engines is the matter of accumulating data — much of it obtained from within the engines themselves — and recording it precisely. Such is the continuing assignment of those at Pratt & Whitney Aircraft who are working in the highly complex field of instrumentation.

Pressure, temperature, air and fuel flow, vibration — these factors must be accurately measured at many significant points. In some cases, the measuring device employed must be associated with special data-recording equipment capable of converting readings to digital values which can, in turn, be stored on punch cards or magnetic tape for data processing.

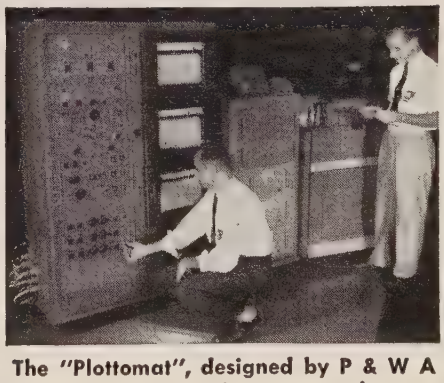
Responsible for assembling this wealth of information so vital to the entire engineering team at Pratt & Whitney Aircraft is a special group of electronic, mechanical and aeronautical engineers and physicists. Projects embrace the entire field of instrumentation. Often involved is the need for providing unique measuring devices, transducers, recorders or data-handling equipment. Hot-wire anemometry plays an important role in the drama of instrumentation, as do various types of sonic orifice probes, high temperature strain gages, transistor amplifiers, and miniaturized tape recording equipment.

Instrumentation, of course, is only one part of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of combustion, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's engineering students.

Instrumentation engineer at Pratt & Whitney Aircraft is shown investigating modes of vibration in a blade of a single stage of a jet engine compressor.



Special-purpose probes designed and developed by P & W A engineers for sensing temperature, pressure and air flow direction at critical internal locations.



The "Plottomat", designed by P & W A instrumentation engineers, records pressure, temperature and air flow direction. It is typical of an expanding program in automatic data recording and handling.

World's foremost designer and builder of aircraft engines

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(Continued from Page 35)

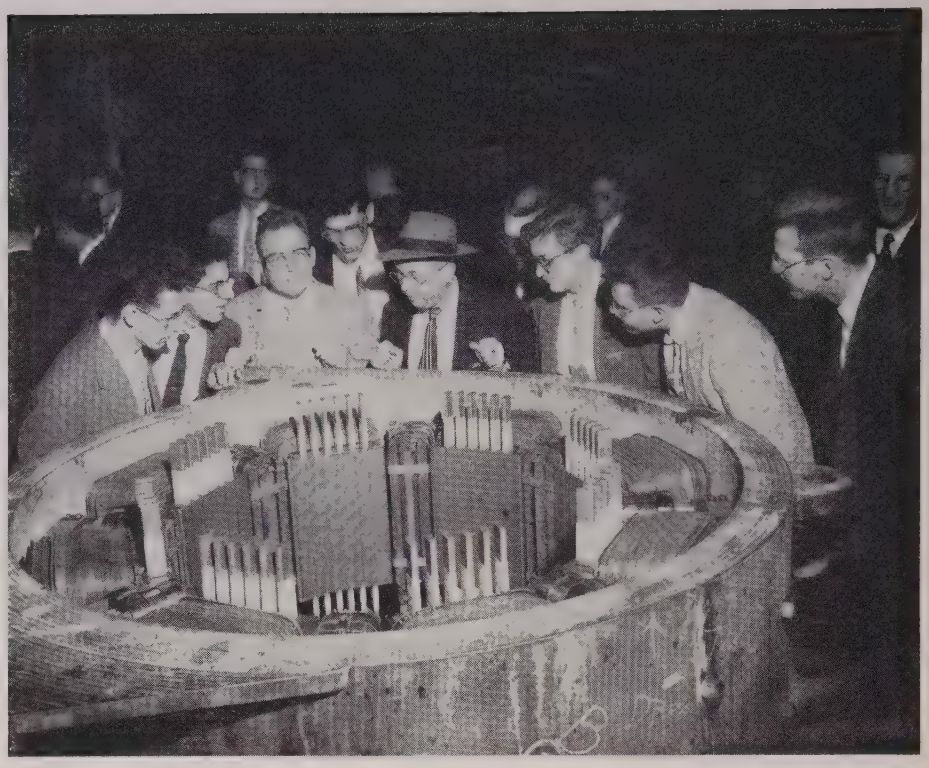
bypass Oak Creek for a tour of WEPCO's Milwaukee facilities. At the Store and Equipment Building we were divided into groups of five and six to tour the facilities by auto. We then saw the company's 96th St. Substation, 72nd St. Substation, the Electric Testing and Meter Division as well as Trouble Division office in the Hillside Building and the 37th St., 28th St., and Westown Substations, winding up at the Public Service Building, headquarters of the company.

At these outlying facilities we saw stock rooms, training centers, facilities for transforming 132,000 kv to 26,000 kv and then to 5,000 kv, the landscaping and building facilities needed to cope with not only utility, but aesthetic and public opinion requirements in the different areas of the city, some outlying and some congested. The flying trip pointed out problems of a utility that are not strictly of an engineering nature, but which must be met. Squirrels must be discouraged from entering transformers with the attendant fur flying. Transformer noise must be cut down by enclosure, or removal from congested area, and a multitude of other problems.

At the Public Service Building, we were shown the Central Load Dispatching Board, where power through the area is controlled as needed by the company's load dispatchers via huge panels and automatic electronic devices. We also saw the facilities the company has built for its employees including a spacious modern lounge and dining room, which not only enhance employee morale, but serve as demonstrators for electric light display effects.

Our trip ended with a fine roast beef dinner at the Milwaukee Athletic Club as guests of WEPCO. After dinner we were given the story of a power company via slides, movies, blackboard and lecture from power plant to lines, to transformers, to meters. Following the formal section, we split into informal groups for discussion prior to returning to the hotel. One obliging WEPCO representative, returned to the hotel to further discussion of public utilities with us over a glass of Milwaukee brew.

Friday morning came quickly as 6:30 a.m. dawned and we checked out of the hotel. Our baggage safely stored on the bus, we proceeded to Louis Allis Co., south of Milwaukee's central business area. Here several recent UI grads met us to conduct us through the plant's facilities. Both small motors and motors of up to 1,000 hp are manufactured. We saw the operations from winding to assembly. Squirrel-cage, splash-proof, fan-cooled, totally enclosed, sanitary, explosion-proof, self-cleaning and a multitude of other motor types were seen, both AC and DC as well as a staff of extremely attractive young women who worked in the offices. Our group was very much impressed. Following our tour we went to the restaurant south of the plant for a buffet-style lunch of baked ham and fish. Company officials gave brief talks on the firm and informal discussions followed.



Members of the Electrical Engineering Power Option group view a DC stator at Allis Chalmers Co., in Milwaukee. (Photo by Allis Chalmers)

Leaving the hotel at 1 p.m., our slightly foot-weary group traveled to Cutler-Hammer Co., manufacturers of motor controls for air conditioning, heating and ventilating, pumps and compressor's among others. In the company's main plant we saw testing facilities for controls as well as small switching units for airplane use. These were the size of matchbooks, while at the firm's 30th St. plant we saw huge control panels being assembled. The comparison was somewhat staggering. An informal coke, coffee and doughnut session in the plant offices ended our tour.

With numb feet and weary bodies we walked to the bus for the trip back. Our final stop was at the Wisconsin-Illinois state line at a restaurant owned by two UI Mechanical Engineering graduates who had gone into the restaurant business. Several Chicagoans on the trip left the bus on various points around the Chicago area. (The bus bypassed Chicago to make better time to Champaign). The official part of our tour ended late Friday with weary seniors departing the bus for home.

The results of the tour aren't readily tangible. No recruiting drives were held at our destinations. We were shown the facilities as time allowed and told of opportunities for employment with each firm, but never pressured or pressed. A friendly informality prevailed as we saw in some better light what was in store for us in the future.

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Of The Illinois Technograph published January, February, March, April, May, October, November, December, at Urbana, Illinois for October 1, 1956

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Illini Publishing Company, Champaign, Illinois;

Editor, Harry Hirsch, Champaign, Illinois;

Business manager, Donald K. Georgi, Champaign, Illinois.

2. The owner is: the Illini Publishing Company, a non-profit corporation.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Peter P. Philhower, Circulation Mgr.

Sworn to and subscribed before me this 9th day of October, 1956.

(SEAL) Margaret E. Cain.

(My commission expires Dec. 31, 1958)

Four top scientists discuss creative thinking before fellow research men and engineers at a Joint Technical Conference held in French Lick, Indiana, by Standard Oil and its affiliates. Panel members were, left to right above, E. L. d'Ouville, G. W. Ritter, P. C. White, and T. A. Abbott. Moderator was Joseph K. Roberts, left inset, general manager of research and development for the parent company.

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The contributions of Standard Oil scientists, working in extensive laboratories and with the finest equipment, have been outstanding. To give them even greater opportunity to exchange and develop ideas, Standard Oil uses the most modern techniques for stimulating creative thinking.

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In such an atmosphere of progress, young scientists and engineers find great opportunities to make positive contributions and build interesting careers.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

Inspection Trip Schedules

Although the full itinerary of the senior inspection trips cannot be given, the following list contains the industries visited by each department of the College of Engineering on its inspection trip.

Aeronautical Engineering

McDonnell Aircraft Corp., St. Louis

Agricultural Engineering

Butler Manufacturing Co., Galesburg
Monmouth County SCS Office
Old Tom Creek Small Watershed Development
John Deere Spreader Works, East Moline
GBH-Way Homes Inc., Walnut
Alfred Meyer Farm, Amboy

Ceramic Engineering

Streator Brick Co., Streator
Laclede Christy Co., Division of H. K. Porter Co., Inc., Ottawa
Libbey-Owens Ford Glass Co., Ottawa
Picard China Co., Antioch
Allen-Bradley Co., Milwaukee
A. O. Smith Co., Milwaukee
Globe Union Co., Centralab Division, Milwaukee
Chicago Vitreous Corp., Cicero
Hotpoint Co., Chicago
Universal Atlas Cement Co., Buffington, Ind.
Harbison Walker Refractories, East Chicago, Ind.
Gary Steel Works, United States Steel Corp.
Gary Sheet and Tin Mill Section of United States Steel Corp.

Chemical Engineering

Kankakee Unit, Joliet Arsenal, U. S. Rubber Co., Joliet
Corn Products Refining Co., Argo
Sinclair Research Laboratory, Harvey
United States Steel Corp., South Works, Chicago

Civil Engineering

Humko Plant, Champaign
Mississippi Valley Structural Steel Plant, Decatur
Nelson Park Bridge, Decatur
Decatur Dam
Water Treatment Plant and Spillway, Lake Bloomington
Construction project in Bloomington area, Felmley Dickerson Co., Contractors
Farm Creek Flood Control Project, Peoria
Illinois River Lock and Dam, Peoria
Peoria Sewage Treatment Plant
Caterpillar Tractor Plant and Proving Grounds, Peoria
AASHO Test Road, Utica
Traffic Interchange, Route 66, west of Joliet
Route 66 Paving Project and Des Plaines River Bridge

Electrical Engineering—Communication Option

Continental Electric Co., Geneva
Motorola Co., Chicago
Bell Telephone Co., Chicago
Western Electric Co., Chicago
Electromotive Division, General Motors Corp., La Grange
Wisconsin Steel Co., Chicago
Rauland Corp., Chicago

Electrical Engineering—Illumination Option

Theodore Roosevelt School, Park Ridge
Maine Township High School, Des Plaines
Benjamin Electric, Des Plaines
St. Raymonds Catholic Church, Mt. Prospect
Glenbrook High School, Northbrook
Lighting Products Inc., Highland Park
Edens Highway Lighting, Tower Road Power Center, Northfield
Northshore Congregational Israel Church, Glencoe
Chicago Lighting Institute, Chicago
Grant Park Underground Garage, Chicago
Prudential Building, Chicago
Container Corp., Chicago
Ryerson Steel Co., Chicago
Commonwealth Edison Co., Chicago
Midway Airport, Chicago
Public Service Co., Maywood
Curtis Lighting, Inc., Bedford Park
Evergreen Shopping Plaza, Evergreen Park

Electrical Engineering Power

Western Electric Co., Cicero
Wisconsin Steel Co., Chicago
Allis-Chalmers Co., West Allis, Wis.
Wisconsin Electric Power Co., Milwaukee
Louis Allis Co., Milwaukee
Cutler-Hammer Co., Milwaukee

General Engineering

Reynolds Metals Co., Brookfield
Chicago Bridge and Iron Co., Chicago
Kearney and Trecker Corp., Milwaukee
Allis-Chalmers Co., West Allis, Wis.
Elgin National Watch Co., Elgin
Wisconsin Steel Works, Chicago

Mechanical-Industrial Engineering

(Six separate trips, with many overlapping stops were made. The stops are all lumped together here for space purposes.)

National Homes Corp., U. S. Route 52 By-Pass, Lafayette, Ind.
Chevrolet - Indianapolis Division of General Motors Corp., Indianapolis
Allison Division of General Motors Corp., Speedway City, Ind.
Western Electric Co., Indianapolis
Bryant Division of Carrier Corp., Indianapolis
International Harvester Co., Truck Engine Plant, Indianapolis
Eli Lilly and Co., Indianapolis
American Foundry Co., Inc., Indianapolis
Food Machinery and Chemical Corp., Hoopeston
Fairmount Glass Co., Indianapolis
Diamond Chain Co., Indianapolis
Stokely Van-Camp Co., Indianapolis
Central Foundries Division of Gen-Motors Corp., Danville
United States Rubber Co., Indianapolis
Kingan Co., Indianapolis
General Electric Co., Danville
South Wind Division of Stewart-Warner Corp., Indianapolis
Linde Air Products Co., Speedway City, Ind.
RCA Victor Television Products, Indianapolis

Metallurgical Engineering

American Manganese Steel, division of American Brake Shoe Co., Chicago Heights.
Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.
American Brass Co., Kenosha, Wis.
American Steel and Wire, Division of United States Steel Corp., Waukegan
Reynolds Metals Co., McCook
Argonne National Laboratory, Lemont

Mining Engineering

Mines and Underground Crushing Plant of Mississippi Lime Co., Ste. Genevieve, Mo.
St. Joseph Lead Co. Mine, Bonne Terre, Mo.
Alcoa Mine, Alcoa Mining Co., Rosiclare
Surface Operations of the Sahara Coal Co., Harrisburg
Underground Coal Mine of Sahara Coal Co., Harrisburg
Salem Water Flood Unit, Texas Co., Salem

UI Engineering Groups . . .

THE SOCIETY COLUMN

Compiled by Don Snedeker, E. E. '58

It is a well established fact that extra-curricular activities play a very important part in a student's life. The student enjoys many benefits from these activities both during his school life and upon graduation when he is seeking a job. The majority of employers today weigh a student's activities on a near equal par with his scholastic achievement. They consider attainments in both fields as characteristic of a well-rounded potential employee.

With this thought in mind, we are initiating The Society Column in this month's issue of *Technograph*. Our purpose will be to keep the engineering student informed of the activities in the many engineering organizations, and the requirements that the student himself must meet to become a part of these activities.

Let us begin this month by defining the various organizations and exploring some of the requirements for membership. Whenever possible, we will include the name of the individual society president who may be personally contacted if further information is desired.

American Ceramic Society (ACS)

Pres. R. J. Herbst—P.G.U.

The student branch of the American Ceramic Society was established at the University of Illinois in 1916. Since that time this society has become an active, effective organization open to all students enrolled in the ceramic engineering curriculum. The big event for ACS members is the annual banquet known as the Pig Roast. Regular monthly meetings are held at which lectures are presented on both technical and non-technical subjects.

American Foundryman's Society (AFS)

Pres. John Miller, 1108 W. Daniel, Champaign

Anyone interested in the foundry industry is welcome to join AFS and attend the lectures and participate in field trips to nearby foundries. Members receive a subscription to the monthly AFS magazine, *The American Foundryman*, and may attend the annual banquet. The AFS also operates a placement bureau which helps undergraduate students to obtain summer employment in the foundry industry.

American Institute of Chemical Engineers (AIChE)

Pres. F. H. Bugajski, 606 W. Ohio, Urbana

The student branch of AIChE is open to students of chemical engineering who desire to learn more about their chosen field and stay abreast of current events in it. At the meetings, which are held every three weeks, the members hear speakers talk on the technical aspects of chemical engineering and the career problems of the engineering field. The society also conducts several field trips.

American Institute of Electrical Engineers Institute of Radio Engineers (AIEE-IRE)

Pres. J. W. DeSimone, 121 N. Race, Urbana

This organization was founded as the AIEE in 1891. At present there are approximately 100 branches, including the UI student branch, open to students enrolled in the electrical engineering curriculum. Lectures, field trips, and social events are all included in the society's program of activities.

American Society of Agricultural Engineers (ASAE)

Pres. F. W. Bauling, 403 S. Sixth, Champaign

Only those students enrolled in the agricultural engineering curriculum may become regular members of ASAE, but any student taking two three-hour courses in agricultural engineering may become an associate member. He may then attend the lectures and various social events held throughout the year. The UI chapter also helps in the supervision of the State Mechanical Corn Picking Contest.

American Society of Civil Engineers (ASCE)

Pres. S. J. Fenves, 702 W. Washington, Urbana

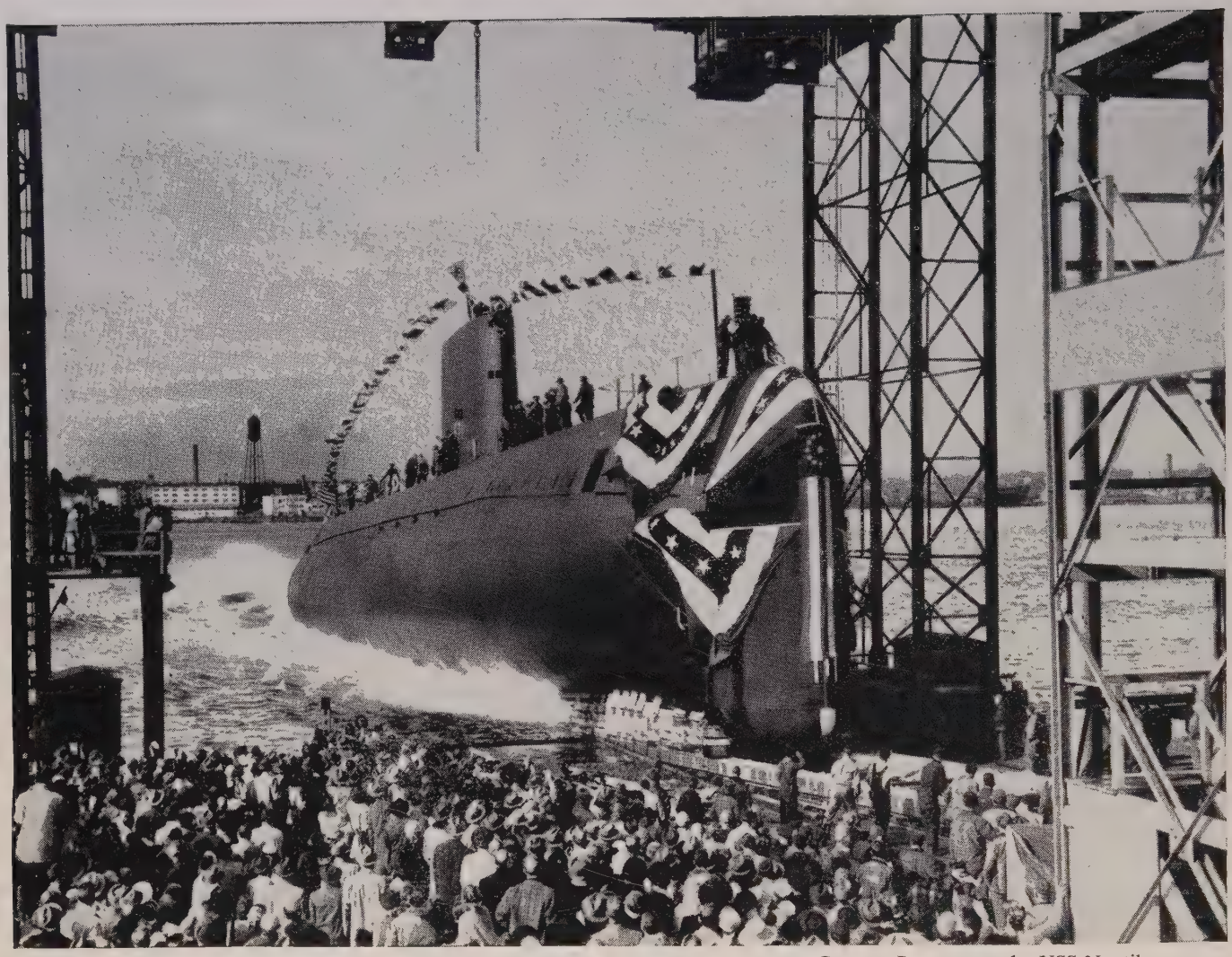
The UI student chapter of ASCE is one of 133 student chapters throughout the country, with a total membership of 7,500. Each spring, representatives attend the Midwest Conference of Student Chapters and participate in discussions and field trips. Regular monthly meetings are held and the year's activities include a student-faculty mixer and a picnic. Students are eligible for membership if they are enrolled in civil engineering or architectural engineering.

American Society of Mechanical Engineering (ASME)

Pres. George R. Powers, 601 S. Anderson, Urbana

The ASME student branch was organized for all students studying mechanical engineering, but is open to all interested students. Members receive the official magazine of the ASME, participate in field trips and attend lectures at the monthly meetings. The ASME also holds joint meetings with the American Foundryman's Society, and the Society of Automotive Engineering.

(Continued on Page 52)



SLIDING DOWN THE WAYS at Groton, Conn., goes the USS Nautilus, newest and fastest member of our underseas fleet. During welding, Worthington heavy-duty turning rolls rotated the hull sections.

How the world's first atomic sub was welded

Welding the hull of the USS Nautilus, world's first atomic submarine, presented a tough problem.

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Turning rolls for submarines aren't all that Worthington makes. The long list of Worthington-designed, Worthington-built equipment includes air conditioning units, construction machinery, compressors, Diesel engines, steam power equipment and, of course, pumps of all kinds. For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Manager, Personnel and Training, Worthington Corporation, Harrison, New Jersey. You may be glad you did.

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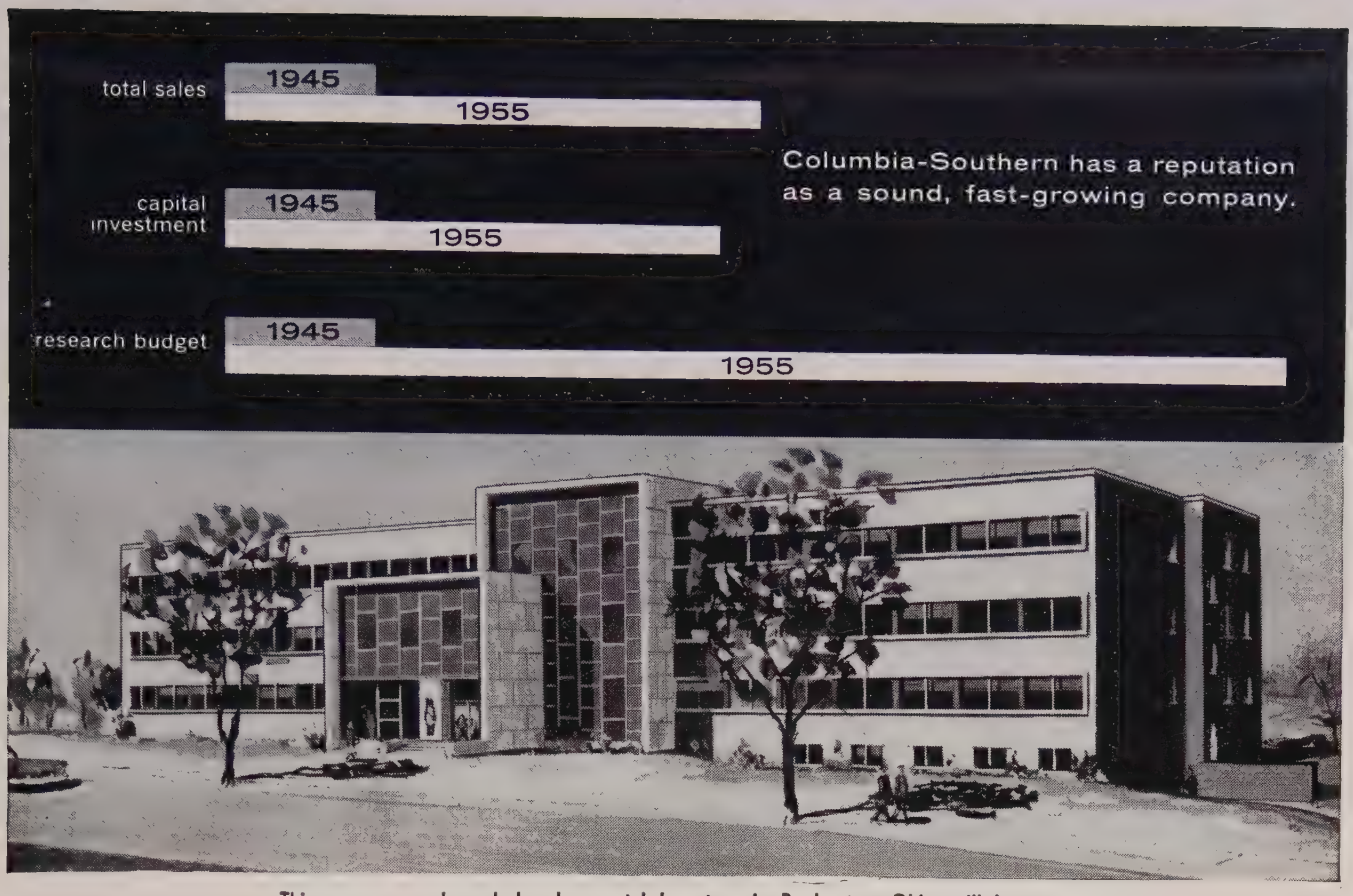

This new research and development laboratory in Barberton, Ohio, will be completed in early 1957. It is a part of Columbia-Southern's constant expansion program.

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Columbia-Southern offers outstanding job opportunities to college graduates of promise. If you would like more information about a career with Columbia-Southern, write today to the Personnel Manager at our Pittsburgh address or any of the plants.

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The Society Column . . .

(Continued from Page 49)

Eta Kappa Nu, Illinois Alpha Chapter (HKN)

Pres. Milton Casteel, 1606 Maryland, Urbana

Illinois Alpha is one of 56 school chapters of Eta Kappa Nu, organized as an honorary fraternity of electrical engineering students. Its membership is selected from those EE students who have maintained high scholarship. HKN activities are varied, including lectures, luncheons and smokers.

Illuminating Engineering Society (IES)

Pres. Dave J. Berrier, 502 E. White, Champaign

The only requirements for membership in the student branch of IES is an active interest in illuminating engineering. However, students enrolled in the illuminating engineering option of the electrical engineering curriculum will be especially interested in the organization. Chapter meetings are held bi-monthly at which lectures on topics of interest to the members are presented.

Institute of Aeronautical Sciences (IAS)

Pres. Don G. Glennie, 714 W. California, Urbana

The UI student branch of IAS is a relatively new organization, having been organized in 1947 for students enrolled in aeronautical courses. The chapter sponsors field trips to aircraft plants, and at their monthly meetings hold lectures by speakers from aircraft plants and industries. An annual student-faculty dinner is held at which the members have a chance to become better acquainted with the instructors in their field.

Institute of Traffic Engineers (ITE)

Pres. R. A. Luettich, 310½ E. Stoughton, Champaign

Membership in ITE is open to all students who are interested in obtaining a better understanding of traffic problems. Lectures on related topics are presented at monthly meetings and each year a field trip is taken to Chicago. Members also receive the ITE magazine as a further insight into the problems of traffic engineering.

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2. GOOD SCHOOL—you are fortunate studying in a fine school with engineering instructors of national renown.
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Illinois Technograph

Editor-in-Chief, Harry Hirsch, 33 E. Healey, Champaign

Each month, the magazine which you are now reading is published by engineering students. These students gain valuable experience in the various aspects of magazine publication by writing the articles, doing illustrations and photographic work and by handling the advertising and business affairs of the magazine.

Mineral Industries Society (MIS)

Pres. W. T. Becker, 706 S. Prairie, Champaign

The MIS is the student branch of the American Institute of Mining Engineers. It is open to all interested students, especially those in mining and metallurgy. Informative lectures are presented at the monthly meetings. Each year the chapter sponsors a softball game with mining students competing against the metallurgical students. Each spring a gold watch is presented to the outstanding senior in mining by "The Old Timers Club" of ASMR.

Sanitary Engineering Society (MuSan)

Pres. A. E. Scalzitti, 508 E. Springfield, Champaign

Mu San was founded at UI in 1911 for students of sanitary engineering and others interested in the field. Every two weeks meetings are held at which lectures of sanitary engineering topics are presented. Field trips are taken to water and sewage works throughout the state. The society also sponsors several social events, including a picnic and a banquet each year.

The Physics Society

This society was founded in 1951 for all undergrad physics students and is the youngest of the engineering societies on campus. Lectures presented at monthly meetings are varied so as to be of interest to freshmen through seniors. Short field trips are taken to the cyclotron and electronic computer.

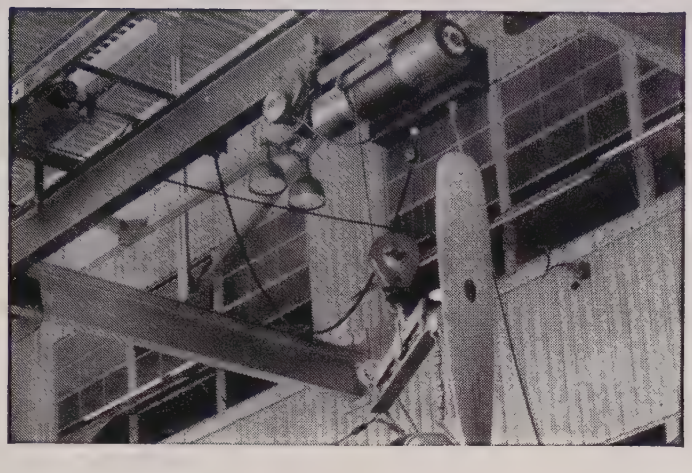
Pi Tau Sigma, Illinois Alpha Chapter

The Illinois Alpha Chapter was founded in 1915 as the original chapter of the fraternity. Junior and senior mechanical engineering students who are of sound character and outstanding scholastic achievement are invited to become members of Pi Tau Sigma. Meetings are held twice a month at which lectures of interest to members are presented.

(Continued on Page 54)

Another page for **YOUR BEARING NOTEBOOK**

How to keep cranes flying



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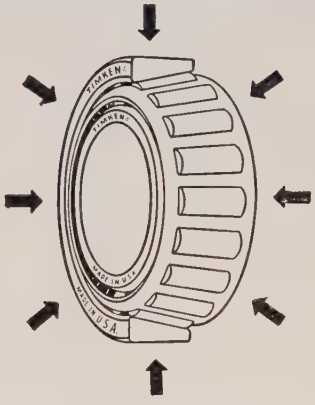
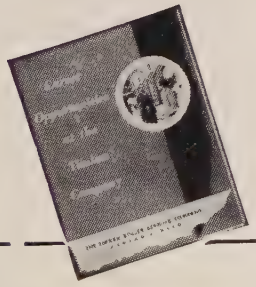


Want to learn more about bearings or job opportunities?



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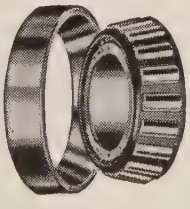

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(Continued from Page 52)

Sigma Gamma Tau

Sigma Gamma Tau resulted from the union of two honorary fraternities: Gamma Alpha Rho and Tau Omega. This is a national organization which honors upper classmen and graduate students in aeronautical engineering who have outstanding scholastic records. The fraternity maintains a counseling service for freshmen and sophomore aeronautical engineering students.

Sigma Tau, Theta Chapter

Pres. Ron Kareken, 112 E. Daniel, Champaign

Theta chapter is one of 29 chapters of Sigma Tau, an honorary fraternity for students in all of the various branches of engineering. Engineering students who maintain a grade point average of at least 4.0 are eligible to become members after their freshman and sophomore years. Each semester a smoker and an initiation banquet are held in addition to the regular business meetings.

Society of Automotive Engineers (SAE)

Pres. J. R. Suhrs, 112 East Daniel, Champaign

Founded in 1949, the UI chapter of SAE is for mechanical engineers and others interested in the automotive industries. Members may attend the lectures and field trips presented by the chapter and they receive a subscription to the official magazine of the society, *The SAE Journal.*

Tau Beta Pi, Illinois Alpha Chapter

Pres. Ken Derby, 313 E. Armory, Champaign

Tau Beta Pi is a national honorary engineering fraternity founded in 1885. Since then it has grown steadily until today there are 90 active chapters. Junior and senior engineering students who meet the rigid scholastic requirements are invited to become members. Chapter representatives attend the national convention each year.

"Broken off your engagement to Mary?"

"She wouldn't have me."

"You told her about your rich uncle?"

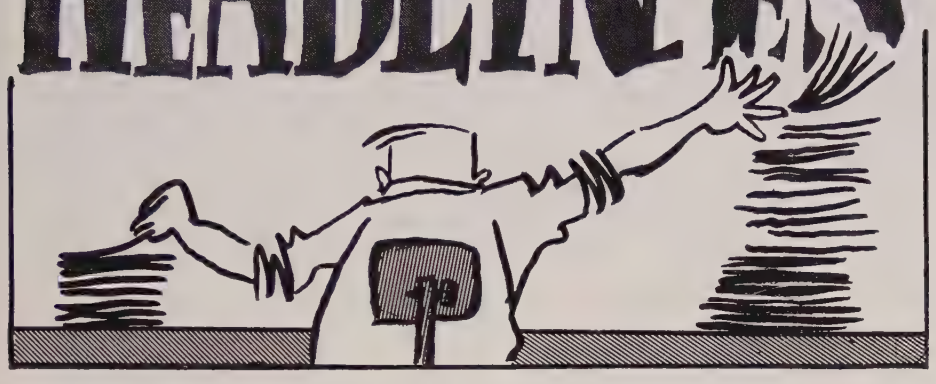
"Yes. She's now my aunt."

* * *

Employer: "What do you mean by telling me that you had seven years experience in a bank when you never held a job before?"

College Grad: "Well, you advertised for a man with imagination."

SKIMMING INDUSTRIAL HEADLINES



edited by Harry Hirsch, E. E. '57

Automation

Automation is not the sole answer to increased industrial production in the labor-short decade ahead, Dr. W. R. G. Baker, a General Electric Company vice president, said in an address to the annual convention of the Standards Engineers Society. Without increased standardization of industrial and engineering processes, "automation cannot ever fulfill its potential usefulness," he said. He defined standardization as "in most instances, simplification."

Although standardization based on interchangeable parts is now an old story, "just think what would happen to our economy and our standards of living if all (parts) had to be made and fitted by hand," Dr. Baker added.

The G-E vice president, who is also president of the Radio-Electronics-Television Manufacturers Assn., told the standards engineers that as more and more companies turn to various types of automation, there is an "ever-burgeoning need for engineering standards." However, he added, "I am sometimes sorry to see that such an important thing as standardization is frequently met by opposition from the people who could most profit by it."

Stating that in 10 years our present population of about 168 million will probably swell to the 200 million mark, the RETMA president told the engineers that "we cannot wait until the 1960's if we are to have in place in time the manufacturing and commercial facilities, the homes, transportation, schools and hospitals required to fill the needs of 200 million persons."

He said the nation's industries must be willing to embrace change and invest more in productive machinery and methods to produce 40 per cent more goods and services with only 14 per cent more workers. "In plain words, that means more automation," he explained.

"If automation is to be the salvation of our economy, then standardization is the handmaiden of automation. I say this because without increased standardization, automation cannot ever fulfill its potential usefulness."

He advised the engineers to "make it a point always to show the individual concerned how engineering standards can help. He may lose some of the variations he had in the past but his overall efficiency will be increased," Dr. Baker said.

Univac Uses

UNIVAC—the electronic data processing system recently installed at the East Pittsburgh plant of Westinghouse Electric Corp.—has started computing the payroll for some 14,500 plant employes and maintaining inventory control of more than 33,000 storercom items. L. B. McCully, vice president of the East Pittsburgh divisions, said UNIVAC will also act as "paymaster" for approximately 4,200 Westinghouse employes located at the company's research laboratories and Pittsburgh headquarters.

McCully said that in the near future the machine will be used to help design complex coils for large motors and generators. The computer will not only make the design but will also prepare and print out complete manufacturing information for shop use in construction. "Our plans call for a completely integrated operation—from design specifications to manufacturing information—on a number of major types of apparatus made at East Pittsburgh," he continued. "Our experience indicates that UNIVAC does a remarkable job of boiling down a huge mass of apparently unrelated data into understandable form so that the information can either be interpreted and applied by our employes, or handled by the computer itself as in the case of payroll preparation," McCully said.

In making up the payroll, UNIVAC calculates the employe's gross pay, takes into account wage or salary improvement "adders," a cost-of-living provision, and makes all payroll deductions, such as income tax, old-age benefit contributions, etc. The computer automatically decides what deductions are to be taken. It computes the employe's net pay, sorts the pay checks, then writes them out at the rate of 10,000 per hour on pre-punched tabulating cards. After the checks have been written, a special machine separates them, signs them and stacks them in proper order.

UNIVAC is housed in a specially built area over the plant's main entrance and occupies approximately 3,000 square feet of floor space. The unit consists of information translators, tape-handling mechanisms, central computer, supervisory control panel and a high-speed printer which converts magnetic tape results into printed material in any form desired at the rate of 600 lines a minute. The room which houses the unit is completely air conditioned and the central computer is cooled by water maintained at a constant 45 degrees Fahrenheit.

(Continued on Page 63)

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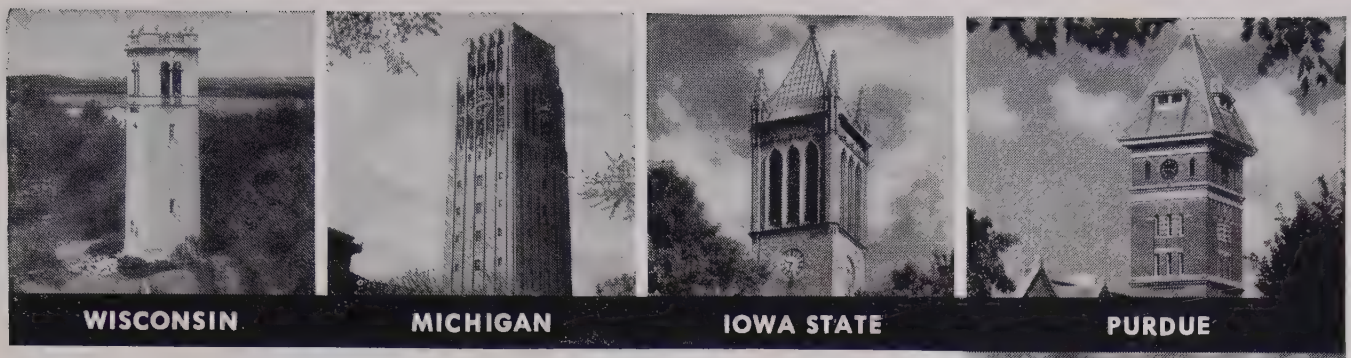
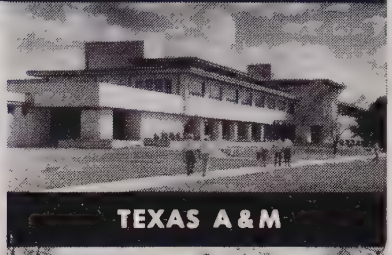
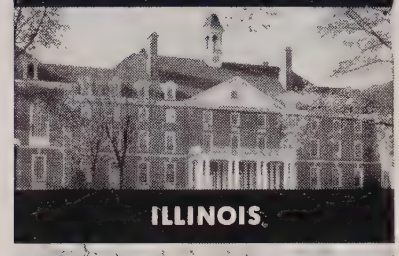
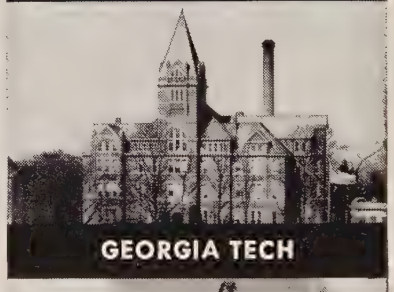


Where do you go from here?







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CAST IRON

CAST IRON PIPE SERVES FOR CENTURIES

Development of an extremely lightweight, rugged, image motion compensating aerial reconnaissance camera has been announced. Here a soldier installs the new KA-20 camera in a high speed drone aircraft. Designed originally for use in drones, the camera weighs only 20 lbs.

(Continued from Page 59)

U. I. Grads

Eight University of Illinois graduates have been awarded Hughes Master of Science Fellowships enabling them to continue their education while employed part-time at Hughes Aircraft Company in Culver City, California.

They are Ronald W. Bocksruker, B.S. Eng.; Robert F. Daly, B.S.E.E.; Harvey M. Endler, B.S. physics; Thomas S. Hartwick, B.S. physics; Robert G. Hering, B.S.M.E.; Herbert D. Marbach, B.S.E.E.; Robert G. Polk, B.S. physics, and Robert William Walton, B.S.E.E. All are 1956 graduates.

The former Illinois men and 192 others from 75 other universities who also were granted Hughes fellowships, are taking advanced courses at universities in the Los Angeles area while employed in Hughes research and development laboratories in practical work closely allied to their studies.

Bocksruker, Daly, Hering, Marbach and Walton are attending University of Southern California; Hartwick and Polk are studying at University of California at Los Angeles, and Harvey M. Endler is attending California Institute of Technology.

Hughes manufactures electronic armament control systems for jet interceptors, Falcon air-to-air guided missiles, cathode ray storage tubes and several types of semiconductors. Other fields of activity include digital computers, ground radar, microwave devices and antennas, radomes and precision plastics, communication systems and miniaturization. All eight men receive salaries from Hughes as well as payment of tuition, books and fees.

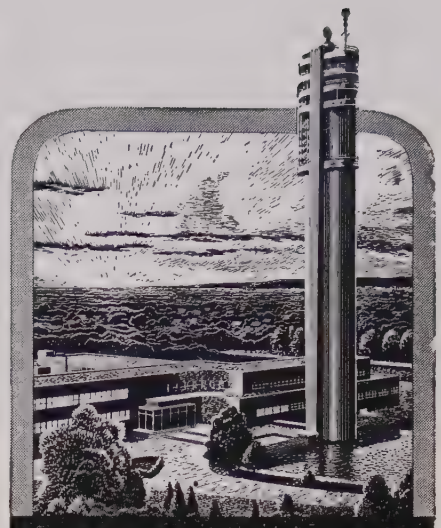
Missile Camera

A rugged, lightweight aerial reconnaissance camera developed by Hycon Mfg. Co., Pasadena, Calif., was announced recently. Designed for use in missile and high speed drone aircraft, the camera can also be used for more conventional aerial reconnaissance tasks.

Known as the KA-20, the camera uses 9 x 9-inch film and a 16-inch metrogen lens to provide a maximum area of coverage. It weighs only 20 lbs., one-fifth the weight of comparable aerial cameras. Built-in Image Motion Compensation, which compensates for the airplane's forward speed at the time the exposure is made, assures sharp photography. Because of its size, light weight, and 9 x 9 format, the camera has application in all types of aerial platforms, both manned and unmanned, where weight is a critical problem.

Missile and rocket use is completely possible with the new KA-20, since it has repeatedly withstood launching and landing loads of 40 G's.

The first KA-20 was made specifically for installation in the Radioplane RP-71 drone. It was developed under the direction of the Signal Corps Engineering Laboratories, Fort Monmouth, N. J.



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Wheel Tester

The world's largest inertia dynamometer for laboratory testing of full-scale railroad wheels is now in operation at U. S. Steel's Applied Research Laboratory, a division of the new Research Center in Monroeville, Pa. Scientists at the Center were responsible for the functional design of the new machine, on which standard railroad wheels from 30 to 48 inches in diameter can be tested under normal or exaggerated conditions simulating factors of loading, braking and tracking encountered in actual service. The dynamometer consists principally of a mill-type electric motor, a variable-weight fly wheel, a track wheel, a spring loading device, a braking mechanism, ultra-modern instrumentation and both automatic and manual controls. The entire device, a two-story installation of about 125 tons of steel-reinforced concrete and 100 tons of machinery, rests on a mounting specially designed to reduce vibration to a minimum. The bulk of the installation is below ground.

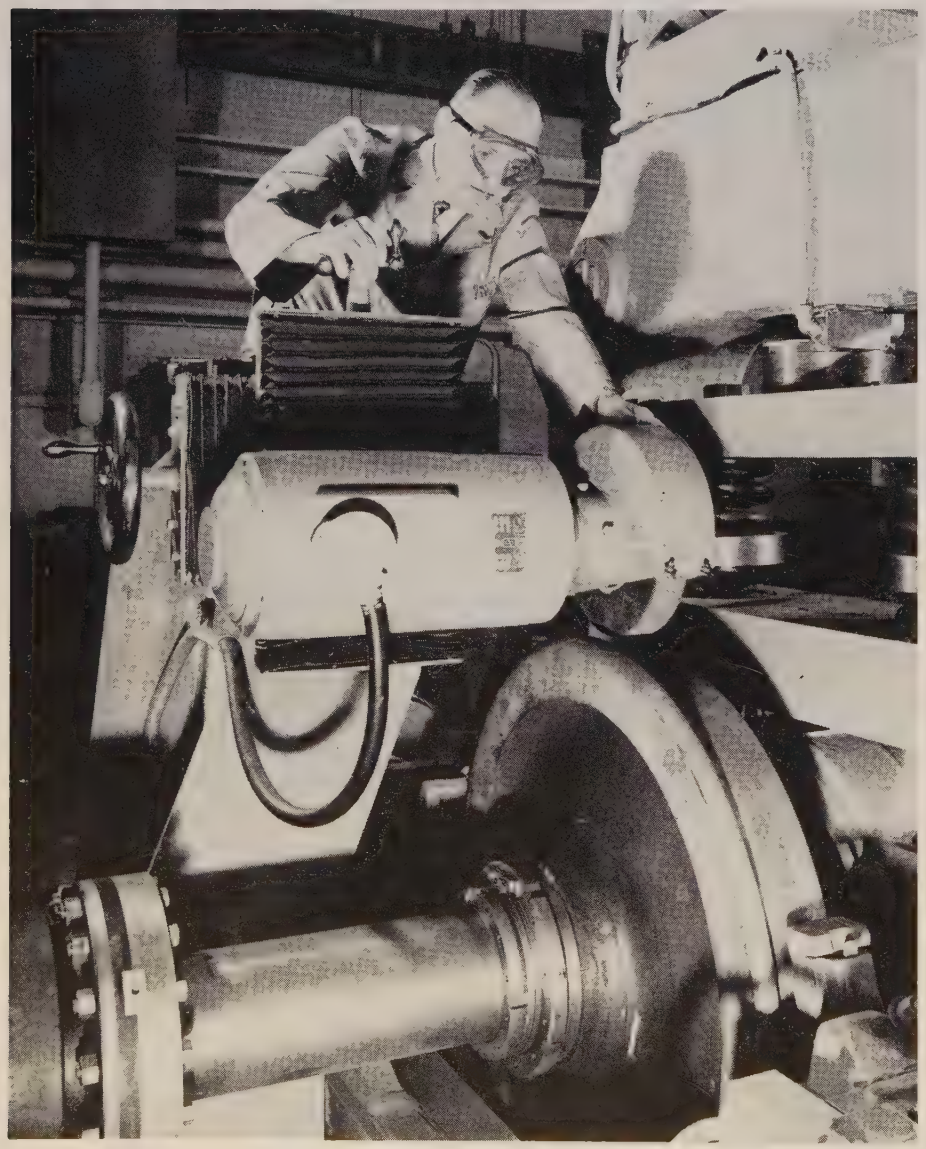
The direct-current, mill-type electric motor has a power output up to 450 horsepower. It can be rotated at various controlled speeds up to 1,500 revolutions per minute. This is equivalent to 161 miles per hour on a 36-inch-diameter wheel. Deceleration as well as acceleration rates can be closely controlled.

The new dynamometer is a completely integrated unit. Direct current is supplied by a 250-kw motor generator with a 200 per cent overload rating. Auxiliary units supply forced lubrication, hydraulic pressure and pneumatic pressure. The variable-weight fly wheel is made of a series of removable discs that fit on a tapered shaft and are bolted to each other. With all 14 discs in place, the motor will bring the dynamometer up to top speed in less than six minutes. When rotating at top speed, a maximum energy of 68,500,000 foot-pounds can be imparted to the test wheel. This is enough energy to throw a 16-pound bowling ball from New York to Chicago, or to lift the ocean liner "Caronia" one foot from a dry dock cradle.

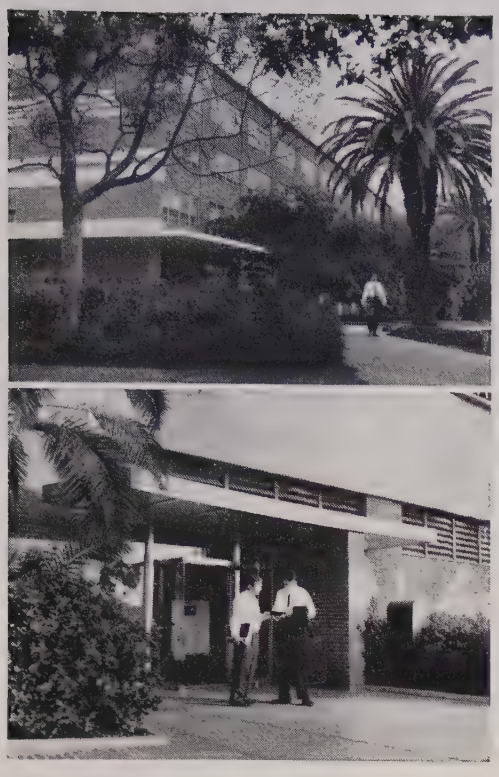
With such high kinetic-energy levels available, tests may be conducted at more than twice the levels encountered in modern railroad service. For example, each 40-inch-diameter wheel under the largest present-day diesel locomotives carries a static load of about 30,000 pounds. If the locomotive is traveling at a top speed of 120 miles per hour, in braking to a stop, each wheel must dissipate about 15,000,000 foot-pounds of energy. A 40-inch-diameter wheel being tested on the dynamometer at a speed equivalent to 120 miles per hour can be given an energy potential of 30,000,000 foot-pounds. A unique feature of the new machine is the ability to simulate the loading and tracking of a wheel on a rail. A nine-foot-diameter track wheel with the head of a standard 132-pound rail around the periphery is rotated by frictional contact with the test wheel. Radial loads up to 40,000 pounds can be imposed on the journal of the text-wheel axle through a special bearing. The same bending moment and the same wheel-rail contact pressures that are encountered in actual service may be produced on the test wheel.

To duplicate the tracking of a wheel in service, the 9-foot-diameter track wheel can be oscillated laterally as much as 2½ inches at rates up to 60 cycles per minute. The action of wheels on curved track can be reproduced by lateral movement of the track level. In this fashion, thrust loads up to 15,000 pounds can be imposed on the flange of the test wheel.

Test cycles can be set up for various tests and are automatically controlled. Strip-chart recorders automatically record revolutions per minute, brake-shoe pressures, torque, the integrated torque-time, thrust loads, radial loads, number of revolutions of the test wheel and the track wheel, percentage of slip and the duration of each test cycle. All instrumentation is electronically interlocked so that only desired data are recorded. The machine is equipped with many interlocking safety factors that make it inoperative if any of the various auxiliary units fail to function properly. Additional safety devices are designed to stop the test cycle and apply regenerative braking to the motor if the lubrication system should fail, if the brake shoes or track wheel should exceed preset limits or if the bearings should overheat. The dynamometer can also be used for fatigue testing of standard railroad axles.



The world's largest inertia dynamometer for testing full-scale railroad wheels is installed at U. S. Steel's Applied Research Laboratory in Monroeville, Pa. A lab technician is shown adjusting the heavy grinder for dressing the tread on a wheel to be tested. (Photo by U. S. Steel)



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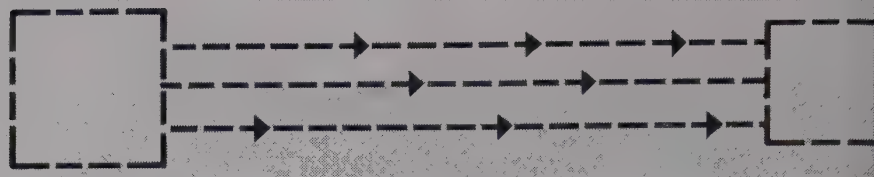


The Importance of

Coverings and Sheaths fo

THE TERM "COVERINGS", as applied to insulated electrical wires and cables, refers to a relatively continuous homogeneous layer or layers of impervious and inert material, applied over an insulated conductor or conductor assembly for the purpose of protecting such conductors from moisture, chemical attack and mechanical damage. Coverings may be colored to indicate circuit identification. Chemical attack refers to damage to the insulation resulting from acids, alkalies and other chemicals in the atmosphere, the ducts or soil in which the cables may be installed. Mechanical damage may result from the abrading, compressing, cutting and tearing forces to which the insulation may be subjected during installation and service.

Coverings may be made of metallic or non-metallic materials. Metallic coverings may be, (1) a continuous metal tube over the insulated conductor, usually made of lead and known as a lead sheath, (2) metal tapes applied spirally about the insulated conductor and referred to as an armor or a shield, depending on the purpose for which it is used, or, (3) metal wires applied spirally either in one direction or in the form of a braid, and again known as an armor or a shield. Armor is a covering applied primarily for mechanical protection or to add strength while a shield is applied to protect the insulation from electrical stresses or for safety purposes. Non-metallic coverings may consist of, (1) a continuous layer of vulcanized rubber or rubber-like material, generally neoprene, or a thermoplastic material, called a jacket, (2) spirally applied, moisture-resistant fibrous yarn, usually cotton or jute, (3) moisture-resistant fibrous tapes, or, (4) moisture-resistant fibrous braids. Combinations of two or more of these may be used as explained later.

The kind and number of coverings used is determined largely by the size of the conductor or cable, the type of insulation on the conductor and the installation conditions. The following is a brief outline of the types of coverings required for the more important types of insulations and installation conditions.

INSTALLATION in DRY CONDUITS and DUCTS

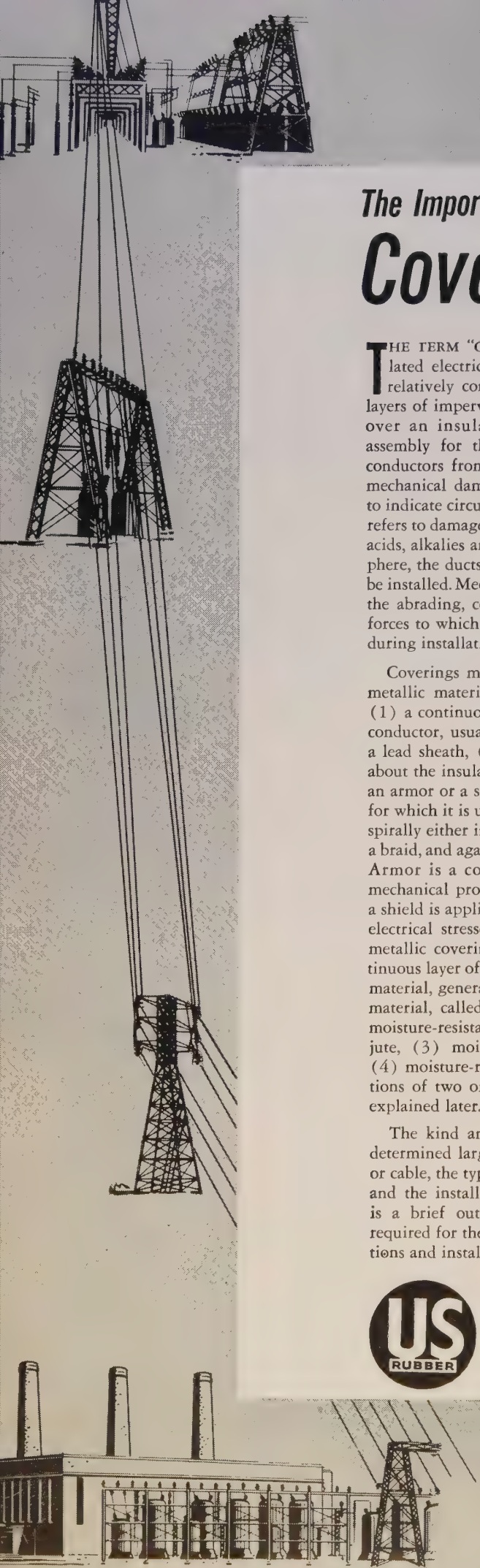
Single-conductor rubber and varnished-cambric insulated cables require a covering over the insulation consisting of a moisture-resistant cotton braid on the small sizes and a double braid or tape and braid on the large sizes for protection against mechanical damage. On 600 volt cables for installation in buildings this covering must be flame-resistant, and is usually colored for circuit identification. A thin layer of neoprene may replace such fibrous coverings on rubber-insulated cables. Paper-insulated cables require a lead sheath for retention of the impregnant and for mechanical protection. Single-conductor polyvinyl chloride insulated cables usually require no coverings since they are generally considered resistant to flame and chemical and mechanical damage.

Multiple-conductor cables which consist of two or more single conductors assembled as a unit are protected by an outer covering. The individual conductors of multiple-conductor rubber insulated cables are generally protected by a single fibrous covering. The outer covering of multiple-conductor cables usually consists of a tape and moisture-resistant cotton braid on rubber and varnished-cambric insulated cables. A neoprene jacket may replace the outer braid on rubber-insulated cables. A polyvinyl chloride jacket is generally used on polyvinyl chloride insulated multiple-conductor cables. Multiple-conductor paper-insulated cables have a lead sheath over the assembled insulated conductors.

INSTALLATION in WET CONDUITS and DUCTS

The coverings described for use in dry locations on both single- and multiple-conductor cables are suitable for use in wet locations, except that a lead sheath is required over varnished cambric, paper and non-moisture-resistant rubber and polyvinyl chloride insulations.

Moisture-resistant rubber insulation requires mechanical protection in the form of a fibrous covering or coverings or a neoprene jacket. A neoprene jacket is preferred because of its greater resistance to deterioration in wet locations. Moisture-resistant polyvinyl chloride may be



US RUBBER **United States Rubber**

nsulated wires and cables

used without a covering on single-conductor cables.

AERIAL INSTALLATIONS

The types of coverings described for use in wet locations are generally suitable for aerial installations but greater thicknesses of non-metallic coverings, particularly for single-conductor cables, are required. Fibrous coverings for aerial use are usually made of moisture-resistant jute, sisal or loom-woven cotton of large size. Neoprene jackets on single-conductor cables for aerial installations are about 50 per cent greater in thickness than those used for duct installations. These thicker covers provide the additional mechanical protection required for aerial installations. Neoprene jackets are generally preferred over fibrous or rubber jackets because of their greater resistance to weathering. Lead-sheathed cables with the same sheath thickness as used for duct installations are suitable for aerial installations. A lead alloy containing small amounts of antimony or tin is used instead of pure lead to reduce failures due to crystallization.

DIRECT BURIAL

For direct-burial installations, rubber, rubber-like or thermoplastic jackets and lead sheaths are generally used. The jacket or sheath thicknesses are the same as those used for aerial installations. Lead sheaths require protection against mechanical damage. This usually consists of two servings of moisture-resistant jute yarn immediately over the lead, followed by two steel tapes over which are applied two servings of moisture-resistant jute.

SUBMARINE and VERTICAL CABLES

Submarine cables require protection against mechanical damage and additional strength over that provided by the conductors to prevent them from being broken by dragging anchors or other objects. Vertical cables frequently require greater strength for their support than that provided by the conductors. This additional strength and mechanical protection is usually provided by a serving of steel wires which completely covers the surface of the cable. This is known as a wire armor. A bedding consisting of two moisture-resistant jute servings is provided between the non-metallic jacket or lead sheath and the armor wires.

PORTABLE INSTALLATIONS

Cables for portable installations such as those used on dredges, shovels and mining equipment must be flexible and their sheaths must be resistant to abrasion, cutting and tearing. Tough wear-and-weather-resistant rubber or rubber-like jackets are therefore used. Such jackets are generally made in two layers with a reinforcing braid of high-strength cotton yarn between them. The jacket thicknesses for such cables are generally greater for a given size of cable than those of cables for non-portable installations.

SHIELDING

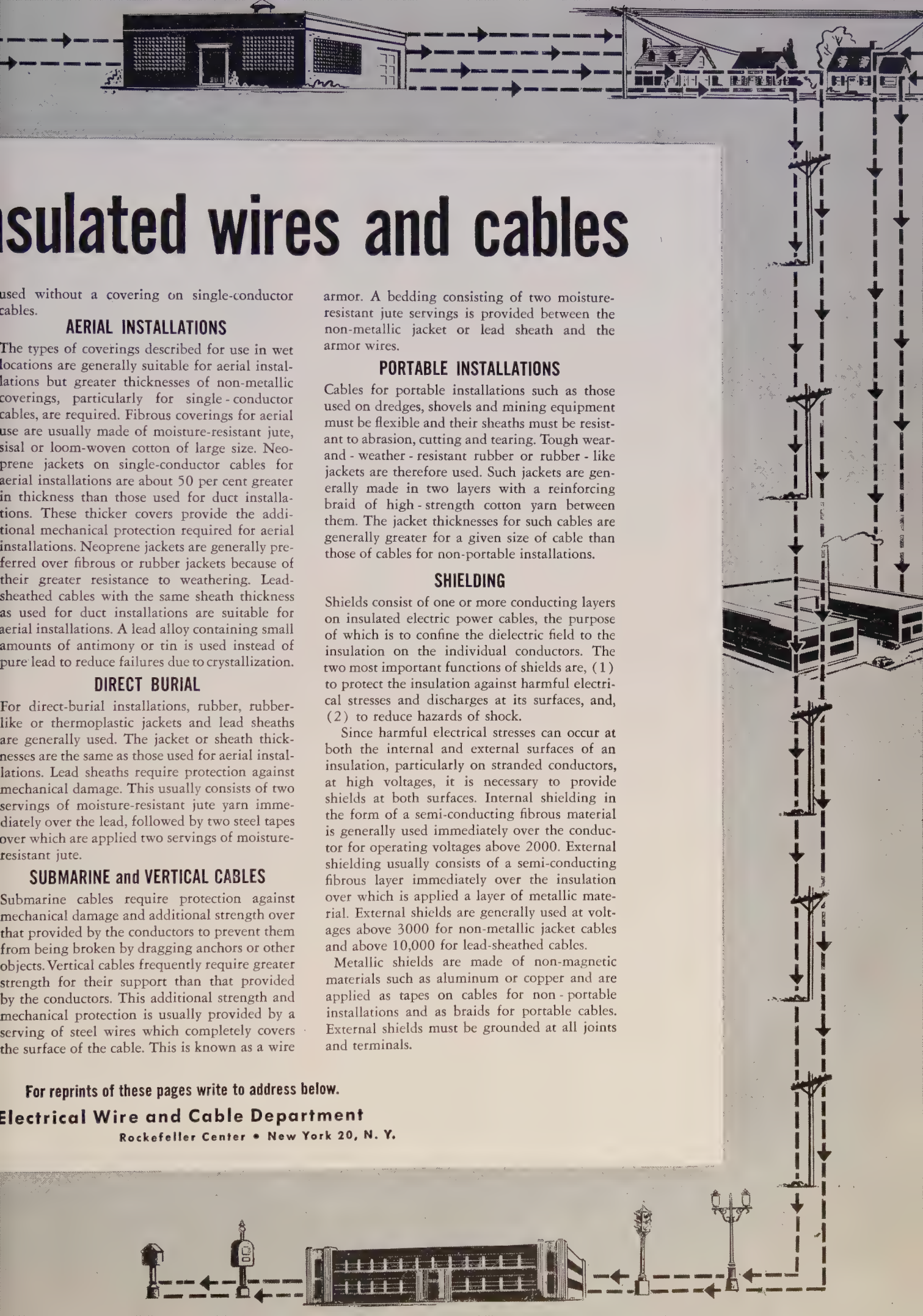
Shields consist of one or more conducting layers on insulated electric power cables, the purpose of which is to confine the dielectric field to the insulation on the individual conductors. The two most important functions of shields are, (1) to protect the insulation against harmful electrical stresses and discharges at its surfaces, and, (2) to reduce hazards of shock.

Since harmful electrical stresses can occur at both the internal and external surfaces of an insulation, particularly on stranded conductors, at high voltages, it is necessary to provide shields at both surfaces. Internal shielding in the form of a semi-conducting fibrous material is generally used immediately over the conductor for operating voltages above 2000. External shielding usually consists of a semi-conducting fibrous layer immediately over the insulation over which is applied a layer of metallic material. External shields are generally used at voltages above 3000 for non-metallic jacket cables and above 10,000 for lead-sheathed cables.

Metallic shields are made of non-magnetic materials such as aluminum or copper and are applied as tapes on cables for non-portable installations and as braids for portable cables. External shields must be grounded at all joints and terminals.

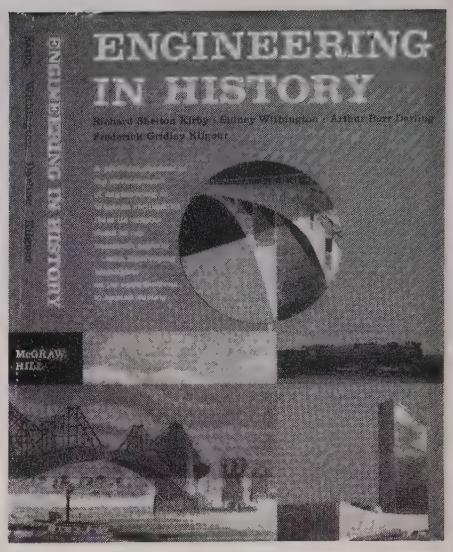
For reprints of these pages write to address below.

Electrical Wire and Cable Department
Rockefeller Center • New York 20, N. Y.



BOOK REVIEW

by Glenn B. Andrews, E. E. '57



The relationship of present engineering activity to other human activity is a very realizable one, and is dependent upon the needs of these other activities. So it has been throughout history from the time man first employed crude weapons to secure his food to the present high level of applied engineering.

Engineering in History presents the interaction between human societies and the progress of engineering. It covers the major achievements and fruits of that progress and presents them in a chronologic evolution through history. The authors have stated that the purpose of the book is, ". . . to discuss engineering in history, not as though engineering occurs in a historical vacuum without reference to other human activities, but as one of many social enterprises."

Engineers and historians worked jointly on the book. This is evidenced by the discussion of the sociological impact, as well as the technical significance, of engineering activity through the ages. The use of technical terms has been kept to a minimum and it may be read with equal interest by both engineers and non-engineers.

The presentation of the main portion of the book is oriented about the great events in history which totally changed the ways of human life. The authors have not undertaken to present a complete history of the development of engineering, since to do so would require several volumes. Instead they have shown the rise in engineering progress will be briefly described here in its relation to the history of mankind. It is intended that this will show the main points of emphasis and give a general picture of the structure of the book.

To begin with, the food-producing revolution (ca. 6000 - 3000 B.C.) brought about one of the most important developments in human history. Before 6000 B.C. man had no domesticated plants or animals. His chief concern was gathering food, but he had no knowledge of the cultivation of plants for producing that food. He was usually nomadic, and followed the source of food supply. It cannot be said that engineering played any part in the existence of man up to about 6000 B.C.

About this time in Africa and Asia Minor the tribes began to domesticate plants and animals to supply themselves with food and clothing. They built houses in groups and cultivated the surrounding land. It was in this period that man found the usefulness of the wheel, the sail for boats, and the harness for oxen. Also men were released from the heretofore universal occupation of producing food to engage in other activities. Some became priests, rulers, or artisans, some of these developing into the first engineers. This period also saw the rise of the enslaving of men and women which obviated any other source of power for more than 3000 years.

The next great event in history was the appearance of the urban society (ca. 3000-2000 B.C.). The men of this period found the advantages of living together in cities rather than villages. The difference in the two is that in the villages most of the inhabitants were engaged directly in the production of foods. The growth of cities stimulated engineering and helped to develop the tools of knowledge fundamental to the engineer. The pyramids of Egypt show skill in the measuring of distances and angles. It has been shown that the Egyptians understood how to determine the slope of a pyramid in terms of its height and the length of its slide. They also used 3.16 (though not in Arabic characters) for the value of pi, the ratio of the circumference to the diameter of a circle, whereas the accepted approximation used today is 3.1416.

The fabulous stories of the highly engineered city of Babylon in Mesopotamia have to a large extent been verified by archeological expeditions. The Babylonians first used the arch in their buildings and built dams and dikes to divert floodwaters of the Tigris and Euphrates Rivers into storage basins for irrigation during drought seasons.

The urban revolution produced the political, economic, religious, and social factors that stimulated the development of engineering. The birth of Greek science (600-300 B.C.) ushered in the widespread use of mathematical principles to obtain the desired structural forms in building. Also a sense of beauty was added to the Greek structures. Tapered columns were used rather than the squat columns so popular in previous civilizations and the great arcs of steps leading to the Parthenon and other great buildings. The Greek engineer was a craftsman who learned under hard apprenticeship, but took much greater pleasure in the artistry of his work.

The Greek civilization, however, never had any centralized political control. It was the Romans who put to their use the advantages of a central administration. They conquered most of the civilized world and maintained political control over it for centuries. Whereas the Greeks were great scientists, the Romans became great engineers. The men of Rome were developers rather than originators. They captured the knowledge of structures and municipal conveniences as they captured their cities and developed these ideas into superior practices of their own. The devotion to public works, such as drainage and water supplies, paved streets, and public baths was the motivation for their engineering feats.

During the latter part of the Middle Ages as the Roman empire was crumbling, a complex civilization was evolving, which rested on non-human power rather than slaves. The continuing rise of Christianity and the correlative aversion to slavery incited the evolution of mechanical power as a replacement for human muscles. Water, wind, and animals became the main sources of power. With these came a greater use of water wheels, pumps, and ditches for drainage and water supply in southern France and northern Italy. The Roman aqueducts were kept in use but water pumps and reservoirs were installed.

The so-called Dark Ages following the decline and fall of the Roman empire produced relatively little engineering advances. These led into the Renaissance period, and with it came the genius of Leonardo da Vinci, painter, sculptor, philosopher, scientist, and practicing military and civil engineer. Leonardo deserves fame not only as a practicing engineer and artisan, but as a prophet of engineering's future. His sketches included such advanced ideas as machine guns, tanks, submarines, flying machines, automatic printing presses, and roller bearings. The period also found such men as Galileo, Pascal, Boyle and Newton studying basic principles as well as applied science. This Renaissance provided the foundations of modern engi-

neering and gave men the tools with which to build the science into a dramatic and dynamic progress.

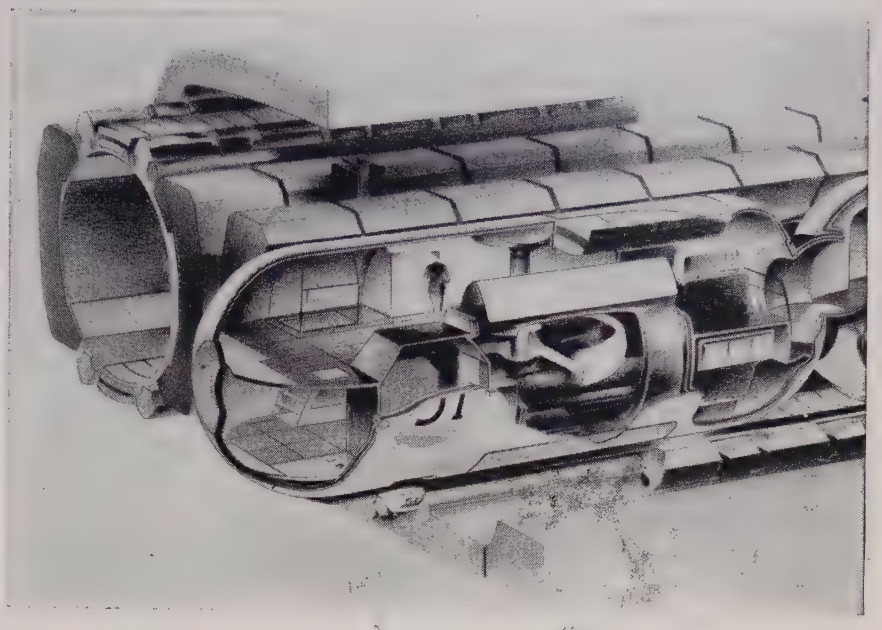
In the 1700's industrial machinery began to replace the muscles of men and the world saw the beginning of the Industrial Revolution or more precisely, the Age of Steam. This phase in the history of engineering made people aware of the great powers available to them in nature. They undertook to understand more of these powers through research in the pure and applied sciences. Out of the research rose the newer fields of electrical engineering, power engineering, and more advanced stages of hydraulic and civil engineering. The world began to recognize the full economic significance of a "scientific method" of engineering. The leading scientists and engineers began to use a more advanced procedure of pre-determining results with mathematics rather than attempting to learn primarily through experimentation.

An extensive application of the scientific method has been used in such fields as electrical engineering. The fundamental scientific discoveries and early application of the electron theory were made by Europeans early in the nineteenth century. American genius has been active in engineering development, engineering production, and engineering service, rather than in fundamental research. This type of genius has evolved the world's greatest electrical industry.

The development of automatic controls in the twentieth century may have as great an effect on man as has mechanical power. Automatic controls provide automatic self-regulation by feeding back to an earlier stage in the process, information concerning a later stage to produce a change in the process, thereby controlling the output. The furnace thermostat is the most common of these devices. Other forms of automatic controls are being used in industry quite extensively where tests or checks are an integral part of the process. Because these controls do not need watching, but need merely an initial setting, they replace the men that previously watched dials and turned valves. High speed electronic computers are used to program these assembly line procedures for the modern automatic factory.

Engineering has become an increasingly powerful factor in the development of civilization. At present, engineering is playing a predominant role in the greatest social evolution the world has ever seen. *Engineering in History* has endeavored to show how human ingenuity and social circumstance have produced engineering progress. Since the past is prologue to the present and the future, a study of this phase of history is very profitable. This book offers a wonderful opportunity for such study.

MARS outstanding design **SERIES**

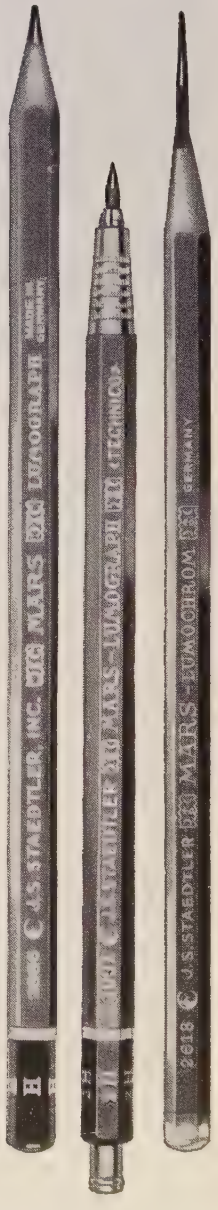


man and motion:

The wonders of the future are still little whispers in men's minds, or maybe — like Detroit Designer Norman James' magnetically suspended inter-city train — a drawing on a piece of paper. Traveling in a vacuum in an air-tight tube, it floats in space, held by a system of magnets built into cars and tunnel. Propelled electrically by "rolled-out" motor, train acts as rotor, tunnel roof as stator. Converter aboard train changes light projected through windows into electrical energy.

No one knows which ideas will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



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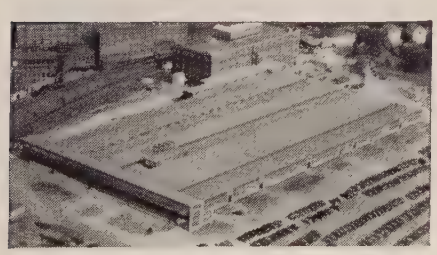
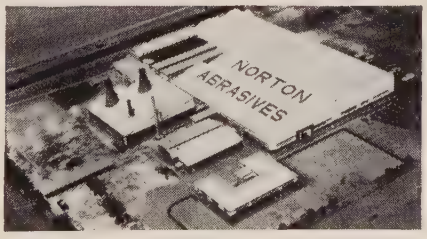
Making better products... to make your products better

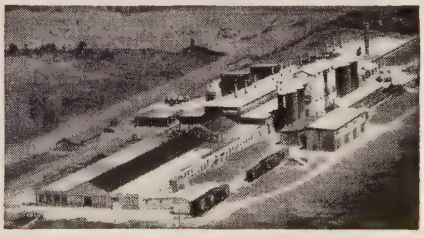
NORTON PRODUCTS: Abrasives • Grinding Wheels
Grinding Machines • Refractories
BEHR-MANNING PRODUCTS: Coated Abrasives
Sharpening Stones • Behr-cat Tapes
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



1948 — WORCESTER, MASS. Plant No. 7 in "Norton City" is the largest, most modern ever built for grinding wheel manufacture. Here, revolutionary advancements in processing equipment and techniques produce grinding wheels of unequalled quality and uniformity.



1951 — ISANDO, UNION OF SOUTH AFRICA. Located in the Transvaal near Johannesburg, and serving all Africa, this Norton plant produces a complete line of abrasive products. Thus Norton anticipates the needs of a continent that, industrially, is just awakening.



1953 — CAP-DE-LA-MADELEINE, QUEBEC, CANADA. Located in a region rich in mineral resources, the electric furnace plant produces CRYSTOLON* silicon carbide for abrasive and refractory uses. Norton's largest plant of this type is in Chippawa, Ontario.

DOW

Saran Wrap is stretched by injecting compressed air to form a bubble ½ mil in thickness which is then compressed and wound.

Bubble, bubble, toil and brainwork...

Dow engineers create modern new plant for Saran Wrap production

Demand was multiplying for Saran Wrap,* the clear moistureproof plastic wrap for foods. A new plant was needed . . . and needed fast.

Dow's engineering and technical staff went to work. Production processes were checked and improved. Mechanical engineers designed new machinery. Electrical engineers introduced new fluorescent lighting (shielded by an entire ceiling of corrugated plastic) eliminating glare from Saran Wrap which would have tired the eyes. Modern plant innovations were widely apparent as the blueprints came in from engineer after engineer.

Then the job was done. Hard work and brainwork had produced an enviable new plant ready to produce in excess of 5,000,000 Saran Wrap rolls a month. Dow-engineered from start to finish, it stands as a testimonial to the depth and talent of Dow engineering and planning. *TRADEMARK

Dow is interested in all types of engineers and scientists who are considering a Dow future. And for the Dow sales program, in addition to engineers and scientists, those with partial engineering and scientific training are also needed.

Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Technical Employment Department, THE DOW CHEMICAL COMPANY, Midland, Michigan, or Freeport, Texas, for the booklet "Opportunities with The Dow Chemical Company"—you'll find it interesting.

you can depend on DOW DOW

NEW HORIZONS IN TECHNICAL WRITING

As any student who has studied a University timetable or catalog can tell, there are many divisions to the field of engineering. The University of Illinois, for instance, offers undergraduate curricula in aeronautical, agricultural, ceramic, chemical, civil, electrical, general, industrial, mechanical, metallurgical, mining, petroleum production and sanitary engineering. When one considers the options, each department offers, the results can be staggering. One of the fields of study is in a little known, but rapidly growing profession. This field, which is of particular interest to members of the Technograph staff, is technical journalism. The following article is from a speech by H. C. McDaniel, Technical Information Manager of Westinghouse Electric. His speech, "New Horizons in Technical Writing", was given before the Third Annual Technical Writers Institute at Rensselaer Polytechnic Institute.

If, after reading this article, you are interested in technical journalism and wish to carry your interest beyond mere thought or wishes, stop by the Technograph office, 215 Civil Engineering Hall, to join us or just for a chat.

I suspect more reputations have been ruined through "predictions of things to come" that didn't come true, than through any one other human activity—including sex. Yet mortal man will continue making predictions in the hope the outcome will make him immortal. And this afternoon, I shall join that intrepid band of mortals who imagine they possess the foresight to predict the future, the future for those of you who plan to make technical writing your profession.

I haven't the slightest idea how much thought each of you has given to the future of your chosen profession, or—your future in that profession for that matter. If you've never given it too much thought, I hope you will give it some consideration during the next fifteen minutes, for in that time I'm going to try to prove to you that you are in a profession that has a real future—providing you do some planning on your own.

At the outset, I'd like to ask a leading question. It is this: "Why did you choose technical writing as a profession?" Academic as this may seem, unless you can give a good sound reason for having chosen this profession as your life's work, how do you expect to succeed in it?

With the thought in mind of finding out why you are in this work, let me give you some idea of what the future may hold for you. It is my firm belief that the need for engineers skilled in the art of communication will be greater by several orders of magnitude—at least by four—in 1965 than today. And, I see no reason why this need will not be double the 1965 figure a decade later. In addition, I believe the demand for imaginative "wordsmithing" skill will increase by almost the same magnitude due to the amazing increase in complexity of production devices, techniques and processes. And at this point you are entitled to at least one, "Ah Nuts! Prove it!"

The proof is to be found in the dynamism of the free enterprise system that is distinctly American. Several factors could be cited to illustrate the vigor and vitality of our economy, but the one that directly reflects its growth and virility is the rate of growth of electric generating capacity. Historically this has doubled every decade since the turn of the century.

At the end of 1954 there was 107 million kw of installed generating capacity— or 650 watts per person. By 1965 this total will be about 210 million or 1100 watts per person, and by 1975 almost 420 million kw or 2000 watts per person. Guestimates for the year 2000 put in at some 1500 million kw.

This explosive growth in the use of electric power can be attributed to greater use of machines to produce the things that will make tomorrow a brighter and more pleasant place in which to live. As a result, you and I are witnessing today production achievements that are remarkable by comparison with yesteryear. Today 62.3 million workers are producing $355 billion in total output while working 39.7 hours per week. By 1965 this work force will be 72.2 million workers, but these people will produce $480 billion in total output and only have to work 39.1 hours per week.When 1975 finally arrives, the work force will have gone to 84.4 million, but it will only work 37.1 hours per week to produce $675 billion output.

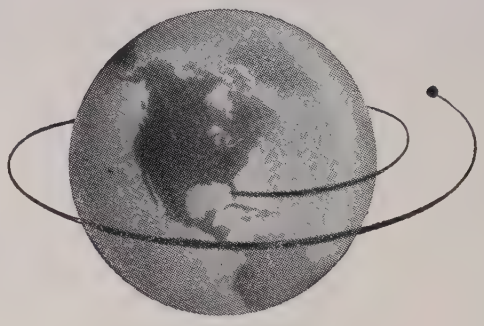
Your consternation is understandable if you are trying to figure out how the Gross Natural Product can increase at a rate almost twice that of the labor force, yet do this in face of a declining work week. The answer lies, of course, in the greater use of mechanized production. The extent of mechanization varies from manual to automatic, with continuous automatic production the end goal for goods prduced in volume or mass.

Regardless of what you may choose to call production process—be it automation or mechanization—the contribution it will make to the living standard of America is significant for only through mechanized production will it be possible to increase the output per man-hour sufficiently to keep the standard of living rising at a rate of three percent a year. Now then. I'll try and relate all this to the need for engineers skilled in the art of communications.

The more continously-automatic production tools and processes become, the more complex will be the drive and control system for there production machines. And while current systems are seemingly complex, they have

Honeywell...*from thermostats to inertial guidance for satellites...*

Two of Honeywell's 12,000 different automatic controls are the Honeywell Round—first entirely new thermostat design in 70 years—and an ultra-sensitive type of inertial guidance system, which will direct the rocket placing the world's first man-made satellite in its orbit.



Over thirty years ago in the *American Mercury* the inimitable journalist H. L. Mencken wrote, "Of all the great inventions of modern times, the thermostat has given me most comfort and joy. Not for a dozen Marconis, a regiment of Bells, or a whole corps of Edisons would I swap the great benefactor of humanity who invented the incomparable thermostat."

Honeywell began in a basement, with the invention of a simple bimetallic thermostat to open furnace dampers on chilly mornings. But extensive research into electricity and electronics, pneumatics, gases, metallurgy, chemistry, plastics, and plain and fancy physics has diversified Honeywell by means of engineering and new-product development into *automatic control for almost every known purpose.*

EXCITING GROWTH: Today, after 72 years, Honeywell has grown and is growing still—the world's leading designer and manufacturer of all kinds of automatic controls. Sales have more than doubled every five years. In the *last 7 exciting years alone* Honeywell has increased sales more than fourfold—from $57 million in 1948 to $244 million in 1955. In these 7 years over 20,000 new employees from all over America have joined Honeywell to find new opportunities. Honeywell now has 31 factories and 160 sales and service offices throughout the world.

MAIN FIELDS: Basically, Honeywell operates in three main fields: heating and air conditioning, industrial instrumentation, and aeronautical controls and ordnance equipment. But the common denominator is always *automatic control.* Heat, color, density, liquid level, humidity, weight, or any other measurable factor—such as attitude deviations of planes or missiles in flight—can all be recorded and controlled.

REMARKABLE DIVERSITY OF PRODUCTS: More than 12,000 *different* Honeywell products give you an idea of the range within which you can build a highly rewarding career. Because Honeywell is operating in almost all the fields known as growth industries, our continuing drive to provide new markets, new products, and new systems promises you a rewarding future.

SMALL UNITS MEAN OPPORTUNITIES FOR YOU: Our employees operate primarily through *personal contacts* with supervisors and fellow workers. Our small units present multiple opportunities for early managerial experience as (1) project leaders, (2) section heads, (3) foremen, (4) department heads, (5) chief engineers, or (6) sales managers. As Honeywell continues to grow, advanced positions are filled largely by men who have worked up from within. So, as an employee, you too will have real opportunities to fill Honeywell's future managerial needs. And Honeywell needs restless men who can accept and discharge responsibilities.

SCIENTIFIC MANAGEMENT: The men who run Honeywell are a top management-science team. Year after year the American Institute of Management has rated Honeywell "excellent"—the top rating among America's best-managed companies. Honeywell's management recognizes that our growth in the challenging future depends in the largest measure upon the initiative, intelligence, and interest of the young people now starting with us.

MODERN PLANTS NEAR SUBURBAN NEIGHBORHOODS: In these expanding units—each conveniently located near pleasant suburban areas with adequate housing, schooling, and recreational facilities—Honeywell offers you rewarding opportunities to do your best work with the most modern facilities:

1. Heating and air conditioning: Complete engineering and manufacturing plants in Minneapolis, Chicago, Wabash, and Los Angeles. We now produce scores of dramatic new controls and systems applicable to *all* types of temperature-control equipment in homes and industry, public and commercial buildings of every type, ships, planes, trains, and buses. Included are systems of zone control, individual room temperature control, pneumatic controls, appliance controls, highly flexible electronic controls, control panels, and the entire range of air conditioning controls.

2. Industrial instruments and controls: Complete engineering and manufacturing plants in Philadelphia. There is hardly a processing industry where Honeywell controls do not function as mechanical and electronic

brains regulating processes better than could be done by human hands or judgement. Honeywell instruments, for instance, are presently in use on every U. S. atomic reactor. Instrumentation holds sweeping potentialities as industry becomes increasingly complex and as automation is applied to more and more of its processes. Typical industrial products include indicating, recording and control types of potentiometers, pyrometers, pressure gauges, industrial thermometers and flow meters, electronic control panels, and thousands of other devices.

3. Aeronautical controls: In addition to extensive research, engineering and manufacturing facilities in Minneapolis, another complete plant is being built in St. Petersburg, Florida, expressly for the development and manufacture of inertial guidance systems. There is also a complete Engineering Development Center for aircraft and missile controls in West Los Angeles. Some challenging engineering interests include automatic flight control systems; hydraulic and pneumatic jet, ram jet, and rocket engine controls; instrumentation; and airborne digital and analog computers. Honeywell is a major supplier of automatic pilots, bombing systems, gyroscopes, and integrated weapons systems for aircraft and guided missiles. The Honeywell electronic fuel-measuring system is the standard of the industry, and Honeywell leads in developing transistorized instruments for aircraft.

4. Precision switches: Engineering and manufacturing in Freeport, Illinois; with additional plants in Warren, Illinois and Independence, Iowa; plus research facilities in Denver. Honeywell's 5000 variations of electrical MICRO SWITCH snap-action and mercury switches are used in countless ways. They permit a slight motion or a small physical force to control an electric motor or current. They are particularly useful where space or weight limitations are important—as in aircraft, missiles and rockets, automatic machine tools, dictating machines, and automatic transmissions for automobiles.

5. Ordnance: Engineering and manufacturing in Minneapolis; a complete new Engineering Development Center for missiles in Monrovia, California; and engineering laboratory facilities in Seattle, Washington. In this Division a great many vital defense products and systems—such as complete missiles and components, fire-control systems, and proximity fuzes are produced.

6. Servo components: Honeywell engineering and manufacturing plants in Boston produce precision synchro motors, gyroscopic instruments, and electro-mechanical servo components for standard use in jet fighters, guided missiles, and bombers. The newest development is a vital control device for the automation of manufacturing processes.

7. Oscillographic and Photographic equipment: The Honeywell plant in Denver produces high speed recording oscillographs, scientific laboratory equipment, and a complete line of Heiland photographic flash equipment.

8. Transistors: The Boston plant develops and manufactures high-output power-type transistors.

9. Research: In a complete Research Center in Hopkins, a suburb of Minneapolis, emphasis placed on fundamentals has led to comprehensive basic research programs in the fields of: solid state physics, metallurgy, ceramics, magnetic and dielectric materials, physical chemistry, electronics, heat transfer, and mechanics. Honeywell is continuing its steadily increasing expenditure for fundamental research.

AT HONEYWELL YOU WILL FIND ADVANCEMENT OPPORTUNITIES IN TECHNICAL AND MANAGEMENT FIELDS:

Research—Development—Production: One of Honeywell's great strengths is the specialized engineering knowledge we can concentrate upon each of many highly technical operations and products. A consistently growing investment in research and engineering projects has in the postwar period increased at a rate almost double that of sales increase. The aggressive policy of "engineering for tomorrow while producing for today" means one out of every ten Honeywell employees is engaged in some phase of our engineering activities.

Almost every type of technical college training can be utilized to advance the art of automatic control. Engineers, scientists, chemists, physicists, metallurgists, and sales engineers are particularly needed. You should possess an intellectual curiosity that compels you to think into and through and around a problem. Yet you should have something more: the faculty of working in close cooperation with fellow engineers on common problems.

Whatever scientific or engineering activity you choose at Honeywell . . . research, design, development, manufacturing, application, or sales . . . you will enjoy the satisfaction of knowing that you are vital to an organization whose growth has helped lead and will continue to lead our country's technical advancement.

Engineering Sales: Honeywell has a great need for the man who likes and wants to sell . . . who is able to find new product applications and expand markets . . . and who can cultivate those markets with consistent energy. You will receive up to five months of special training in one of Honeywell's well-equipped and expertly staffed divisional sales schools.

Honeywell's Training Program: Training at Honeywell is handled in various ways: organized programs for "Learning By Doing"; formal classes during and after working hours; orientation and development programs tailored to individual requirements; and outside study programs, on both undergraduate and graduate levels, with the Company sharing your tuition costs. Honeywell's various locations furnish access to the nation's best technical schools.

NOW, LET US HEAR FROM YOU!

If you would like to know more about the opportunities for you at Honeywell, contact your College Placement Office. Or please write directly to H. T. Eckstrom, Personnel Administrator, (Dept. C56), Minneapolis 8, Minn.

MINNEAPOLIS **Honeywell**

First in Controls

reached a point beyoud which they cannot be economically extended as the life of bearings, commutators, contractors, and electrodes is subject to the law of mathematical probability.

This mechanical impasse was recognized several years ago at which time scientists and engineers began a search for better switching components. It appears the almost perfect soultion has been found in such solid state devices as the magnetic amplifier, the rectifier, and the transistor for these devices have no moving parts, yet when used in control systems, they become static switching circuits.

Here are devices of practically unlimited life requiring negligible maintenance. Obviously, the use of such devices in control systems makes possible circuitry that is more complex by several orders of magnitude—circuitry that will make possible a continuation of the trend toward continuously automatic production.

Coupled with these solid state developments is another development that is every bit as signiffcant. This is the computer—both analog and digital. The computer will make possible verification of postulations never before attempted for it can do routine "pencil and paper" calculations in minutes that when done by hand might take as many hours or days or even months to do because of the number of assumptions that must be made and verifled. This means the engineer will have more time to "imagineer"— to do creative thinking—to do the things he's trained to do. It means he will be devoting his full talents and energies to engineering—not a small fraction to this aspect of his work while the major portion is devoted to detailed and somewhat routinized mathimatical calculations. The engineer's world of tomorrow will be a more stimulating and challenging world—and it will be a faster moving world—thanks in a large measure to the computer.

With systems of the complexity described— and these will be commonplace before 1965— the problem of reducing the functioning to terms understandable to the industrialist will be as challenging to the engineers skilled in the art of communications as the creation of the circuit itself is challenging to the design engineer. Both are important; and both contribute to progress. Therefore, this much may be said of technical writing: the job of reducing to usable form newly-found knowledge is as important as the discovery itself, for unless the signiflcance of the discovery can be explained to others, that new knowledge cannot be put to use by the profession generally. So the need for engineers skilled in the art of communication increases with each new branch that is added to the engineering family tree. Of signiflcance also is the fact that pay advancement are equal to those of any profession.

The qualiflcations needed for this work can be summed up in seven words: Engineering education; Journalistic skill; Imagination; Diplomacy; Cooperativeness.

Qualifications Needed

First is engineering education. It is essential that a technical writer have had a formal engineering education. He must win the confidence of the engineers, have a fair understanding of the matter under discussion, and be able to judge the engineering signiflcance of a particular development.

Next is journalistic skill. A technical writer must have a facility as a writer. This is sometimes called "wordsmithing." This requirement is less tangible than the engineering training required but no less important. In essence, it means a facility in handling words, a liking for writing, and an ability to express ideas clearly, interestingly, and logically. Also, this skill must extend not only to one's own writing but in addition, to one's editing for frequently a critical view must be taken of the writings of others.

How well someone meets these qualiflcations generally is hard to measure but it is extremely important. It must be based on something more than on a vague but common "desire to write." Words are tools of the technical writer. Unless he uses them with pleasure and with facility, he is a misfit in technical writing.

Next is imagination. A technical writer must possess imagination in abundance. This means visualizing an approach that will have a particular appeal and of enthusing the project engineer over the possibilities. It means seeing ways of treating the facts or supplementing the text with visual aids that will add to the reader's interest. He must be able to see in a development a potential story that will be of interest to a well-defined audience. This is sometimes called having a "nose for news." Really it is much more than that.

Then there is diplomacy. A technical writer must possess considerable tact or those personal mannerism qualities usually associated with a successful salesman. When contacting engineers, he must be able, by persuasive methods, to obtain their cooperation in the preparation of material or the presentation of facts. Because engineers are busy and are not too prone to write, considerable skill to win their respect and confidence for the projects in mind is essential.

Finally, there is cooperativeness. Because a technical writer is part of an organization, he obviously must have qualities that are necessary in almost any organization activity. These are: the ability to get along well with fellow technical writers and other members of the organization, and to win their respect and confidence. Involved are such things as punctuality, courtesy, personal neatness, and teamwork. While these seem obvious, otherwise good technical writers have been known to flounder on some of these personal qualifications.

Now then, let's see where the opportunities are for technical writers. I will cover only the major ones. In so doing, the order of presentation is not related to the order of significance.

There are nearly 2000 periodicals published in the United States aimed at 150 different fields of interest in industry and business. A detailed analysis of the editorial content and the readership of each of these magazines can be found in "The Editorial Directory" or "The Standard Rate & Data Service-Business Publications Edition." The former is published by the Galub Publishing Company, New York City; the latter by Standard Rate & Data Service, Evanston, Ill.

In addition, there are some 1500 periodicals published by industry itself that are aimed at this same group of industrial and business readers. The editorial analysis of this group of publications is to be found in "The Nation's Leading House Magazines," published by the Gebbie Press, New York City.

As a cub editor on one of the technical magazines, you start your career writing and editing "news" and "what's new" items. As you gain experience, develop a feel for your readers, and become more facile with words, you'll find your assignments becoming more interesting; more stimulating; more challenging. Assuming you'll continue to do what's expected of you, you'll find from that point on—usually a period of two to four years—that your responsibilities will increase, your progress will be forwardfi and your pay will move upward.

In general, staff editors of scientific society journals and of engineering association magazines do not have the freedom and latitude for editing that an editor has on a technical or trade magazine. There are notable exceptions to this general rule and you can spot these the moment you read the introductory paragraph to one of the articles or papers. Where editing is restricted by rules, the opportunity to flex your imagination and to develop an articulate writing style is inhibited, but there are compensating factors. The editors of these journals sometimes serve as secretary or managing director of the society in addition to being editor and in such capacity are afforded an excellent opportunity to develop their administrative, organizational, and managerial abilities.

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and
DETECTIVE STAINS

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The seven major Divisions of Allied Chemical offer rewarding careers in many different areas of chemical research and development.
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Whenever you drive, you're safer on a highway paved with TARVIA road tar — glare-free in summer, heat-absorbing in winter to melt snow faster.

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61 BROADWAY, NEW YORK 6, N. Y.

Steel is 2 to 3 times stronger than gray iron

Steel is 2½ times as rigid as gray iron

Steel costs a third as much as gray iron

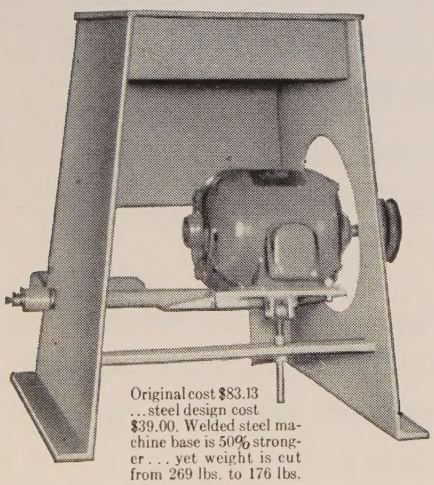
So products properly designed in steel can be manufactured at savings up to 50%

WHAT MAKES A DESIGNER OUTSTANDING?

TO be successful, a designer must first know how to develop products that are profitable to his company. To be profitable, these products must meet competition, yet be manufactured for low cost.

By taking advantage of the benefits of welded steel construction, the alert design engineer has unlimited opportunities for developing new product ideas. He can add improvements to present products, make them stronger, more serviceable . . . while actually reducing the cost of production, as in the example shown.

HOW COST IS REDUCED



Original cost $83.13 ...steel design cost $39.00. Welded steel machine base is 50% stronger . . . yet weight is cut from 269 lbs. to 176 lbs.

It will pay you to keep pace with the newest developments in steel design. Latest information is in Lincoln Procedure Handbook of Arc Welded Design and Practice. Write.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Staff editors of company subsidized engineering magazines work under a broad spectrum of editing freedom. At one end is the almost zero lack of freedom to develop and edit material. At the other end is complete freedom in the choice of material and in the editing of this material. Within these limits, an editor on one of these magazines work much the same as an editor on one of the technical magazines. The principal difference is in his "beat." In the case of the company technical magazine, the "beat" is largely within the company with only an occasional trip outside. No such limitation is faced by the editor on a technical magazine. So, if you are averse to frequent and extensive travel, but want to be in the technical writing profession, a job on a company published technical periodical might be the solution to your problem.

The work of a technical editor-writer in the public relations department of a corporation is quite different from that of a staff editor on a technical magazine—yet, under the right conditions it can be as challenging, as stimulating mentally, and as rewarding financially. I can best illustrate what I mean by describing the Technical Publicity operation at Westinghouse.

A sizeable staff of editor-writers gather, edit, and place in technical magazines and the Westinghouse Engineer technical information about Westinghouse products and services. To do this, each editor-writer is assigned a "beat" of two or three product divisions and one or two engineering service departments. The editor-writers establish personal contact with those doing research, development, desig, manufacturing,and application engineering work, in order to keep fully acquainted with the progress of developments and to guide the planning of publicity for all developments. This includes giving counsel to authors of technical or engineering articles, gathering information and writing news items, new products and sales literature pieces, and similar items of interest to the readers of technical magazines. They assist in planning visual aids, sometimes personally directing the taking of photographs. In addition, they must obtain clearances for publication from interested groups within the Company. They must also plan and assume the responsibility of placement of material with the editors of the appropriate technical magazines.

While all technical information operations of corporations may not embrace all the activities found at Westinghouse, basically all do the same thing in varying degrees. The scope is determined largely by the size of the company. In general, the larger the company, the broader the scope. Conversely, the smaller the company, the narrower the scope.

What holds for corporation public relations departments, holds also for public relations departments of advertising agencies and public relations firms. Here, editorial and advertising functions are more closely related. In general, agency work involves more fact gathering and creative writing than is the case with the corporation. Of interest is the fact that a few agencies have set up a technical information group separate and distinct from their advertising departments.

Then of course there is the advertising and sales promotion departments of companies. The basic function of all such communications is to persuade the reader to buy the manufacturers product. This form of technical writing requires the utmost in imagination and originality. It can be rewarding professionally and financially. And with the razor-sharp competition that exists today, there will always be ample opportunity for an idea-man.

The only other field I want to cover before closing is that concerned with the writing and producing of instruction manuals of all types and kinds. In deference to R. T. Hamlett, I'll limit my remarks very considerably.

This particular field of technical writing literally exploded during World War 11 due largely to the complex military gear that was being produced coupled with the need to tell the boy with a high school education—or less—how to keep this gear functioning. A lot of the engineering know-how during the war has found its way into the design of products for civilian use. As a result, the need for technical writers to produce instruction manuals for industry has grown several fold. This means opportunities exist now where none existed ten years ago. There is little doubt that these opportunities will be ever more numerous in thefuture for reason that products are going to become more complex, not less. As a result, the need for technical writers will continue to increase as the complexity of apparatus increases.

Now then, I'd like to close with these observations: I think technical writing is rapidly assuming the same professional status as engineering; that as with all professions, it too requires its own talents, skills, opportunities, and responsibilities. It is going to be an important profession. It should not be viewed as a profession in which an individual is on the sidelines watching the engineering parade go by. The two compliment each other, for the task of converting information about the engineering developments into printed form usable by the profession generally is as important in the complex industrial world as the creation of the idea itself.

Boeing engineers design America's first jet transport

Pictured above is the full-scale cabin mock-up of the Boeing 707, America's *first* jet transport. In developing this interior, Boeing engineers helped design features and innovations as advanced as the 600-mile-an-hour performance of the aircraft itself.

Pioneering revolutionary new types of aircraft like the 707 is one of the sources of excitement — and satisfaction — that engineers and scientists enjoy at Boeing. This new jet-age transport has already been ordered by 10 major overseas and domestic airlines. These commercial orders, together with Boeing's tremendous backlog of military contracts, mean that this company will continue to expand during the years ahead.

Growth is a Boeing habit. During the past 10 years, for instance, the number of Boeing engineers has increased 400%. Expansion at this rate spells job stability — and plenty of opportunity to move ahead. Boeing promotes from within, and holds merit reviews every six months to give each engineer a *personal* opportunity for recognition, advancement and increased income.

Boeing engineers don't get lost in the crowd. They work in small integrated teams — on such projects, in addition to the 707, as the advanced B-52 and B-47 multi-jet bombers, the BOMARC IM-99 guided missile, the 502 gas turbine, and other developments still under security wraps.

Qualified engineers and scientists of *all* types are needed at Boeing — now. You'll find high starting salaries, and stimulating contact with men outstanding in the world of engineering. Other advantages include liberal insurance and retirement plans, and a choice of modern, young-spirited communities in which to live. Boeing helps arrange special work schedules for engineers taking graduate studies, and pays all tuition and fees. You're missing a bet if you don't at least *find out* how Boeing can help you get ahead in your engineering career.

For further Boeing career information consult your Placement Office or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 24, Wash.

F. B. WALLACE, Staff Engineer — Personnel
Boeing Airplane Company, Wichita, Kansas

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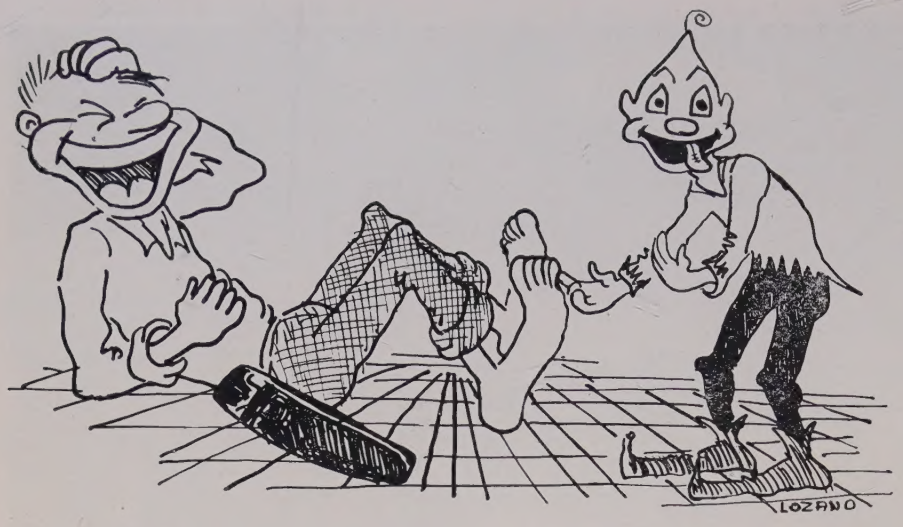

TECHNOCRACKS

Prof.: "Why don't you answer when I call your name?"

Student: "I nodded my head."

Prof.: "You don't expect me to hear the rattle all the way up here do you?"

* * *

Students are like blotters, they absorb what the instructor says, but they get it backwards.

Instructor: "I suppose you wish I were dead so you could spit on my grave?"

C.E.: "Not me. I hate to stand in line."

* * *

The men who go to college,
The he-men and the wrecks,
They do a lot of talking
About beer and also sex.
Now it's my observation,
In spite of all they boast of,
That between beer and women,
Beer's what they get the most of.

* * *

If young girls stay out late, drink, smoke, and pet, men will call them fast. . . . As fast as they can get to a phone.

* * *

Undergrad: "What's the matter, Helen, don't you trust me?"

Helen: "Yes, Frank, I'll gladly go to the ends of the earth with you, but I absolutely refuse to park on the way."

* * *

When a reporter on a mid-western daily was sent out to round up opinion of the man on the street concerning the modern woman, the first person he queried on the subject was a man who had just passed his 101st birthday.

"I'm afraid I can't be much help to you," replied the centenarian regretfully. "I quit thinking about women almost two years ago."

The farmer had been to the big city on business for a couple of weeks. Getting off the train at home town, he happened to run into his hired hand.

"Hi Zeb! What's new?"

"Not much."

"That's fine, boy did I . . ."

"Ceptin we buried your dog."

"You buried my dog? Why?"

"'S daid."

"I figured it was if you buried it. How'd it die?"

"Hoss kicked it."

"Why'd the horse kick it?"

"Spark fell on it."

"Spark? Where did the spark come from?

"From the barn."

"From the barn? What happened to the barn?"

"Burned down."

"How'd the barn catch fire?"

"S'pose it was sparks from the house."

"You mean the house burned too?"

"Yep!"

"How'd that start?"

"Figure the candle caught the drapes."

"Candles? What candles?"

"The ones around yer wife's coffin."

* * *

Betty: "Your new overcoat is pretty loud, isn't it?"

Billy: "Yeah, but I'm gonna buy a muffler to go with it."

* * *

The meek little gent in the restaurant finally sighed and decided to give up his steak. It was tougher than sole leather. He called the waiter and pleaded that it be taken back to the kitchen. The waiter dolefully shook his head and said: "Sorry, pal, I can't take it back now. You've bent it!"

Prof: "Er—my dear, what's the meaning of this vase of flowers on the table today?"

Wife: "Meaning? Why, today is your wedding anniversary."

Prof: "Indeed! Well, well, do let me know when yours is so I may do the same for you."

* * *

"Has your son's college education been of any value?"

"Oh, yes; it cured his mother of bragging about him."

* * *

Phyllis: "Were you nervous when George proposed?"

Mable: "No, dear, that's when I stopped being nervous."

* * *

Diner: "Waiter, this soup is cold. Bring me some that's hot."

Waiter: "What do you want me to do? Burn my thumb?"

* * *

"And what good turn have you done today?" asked the Scoutmaster.

"Well," said a Tenderfoot, "I saw a man beating a donkey and I stopped him."

"Fine," said the Scoutmaster, "What good trait does that show?"

"Brotherly love," chorused the rest of the troop.

* * *

Policeman: "Did you break that window on purpose?"

Boy: "Oh no, sir, I was cleaning my slingshot and it accidentally went off."

* * *

A professor wanted to call a friend in Gopeck. The operator had trouble understanding the name of the town and asked the professor to spell it. "The name is Gopeck, operator," said the professor; "G for gnome, O for one, P for phychic, E for eye, C for chandelier, K for knight."

* * *

"Just look at old Phillips over there —thoroughly enjoying himself. And I have always understood he was a womanhater."

"So he is; but she's not with him tonight."

* * *

He: "Who spilled mustard on this waffle, dear?"

She: "Oh, John, how could you? This is lemon pie!"

* * *

Visitor: "And what's your name, my good man?"

Prisoner: "974238."

Visitor: "Is that your real name?"

Prisoner: "Naw, dat's just me pen name."

* * *

"Whaddya mean, she's a drug addict?"

"Usually under the influence of some dope."